UNIVERSITY OF CALIFORNIA
COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
BERKELEY, CALIFORNIA

DISEASES OF TURKEYS

W. R. HINSHAW

BULLETIN 613

November, 1937

UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA

CONTENTS

DISEASES OF TURKEYS[1]

W. R. HINSHAW[2]

INTRODUCTION

BLACKHEAD WAS CONSIDERED to be the most important disease of turkeys in California until Graybill[3] showed that other diseases were causing much of the mortality. Subsequent investigations have shown that these losses have many causes, some of which have been studied sufficiently to warrant definite recommendations regarding prevention and control, whereas others are still either undetermined or in need of more research.

This bulletin reports progress on certain turkey-disease problems still being studied at this station. It also brings together previously published data both from this station and from other sources. In the first section will be discussed some general principles of prevention and control, applicable to all diseases. Since prevention is the keynote of disease control, very little space will be devoted to treatment.

PRINCIPLES OF DISEASE PREVENTION

The same principles of disease prevention apply to turkeys as to other livestock; and they are even, to a large extent, the same as those applying to human beings. Van Es and Olney[4] summarize the factors conducive to health and body efficiency: "(1) soundness of body and of constitution and vigor, (2) adequate nutrition, (3) suitable environment, and (4) eradication and control of transmissible diseases." Although immunity to disease cannot be guaranteed when turkeys are reared according to these principles, the turkey grower who observes them will increase his chances of raising a profitable flock.

SOUNDNESS OF BODY AND CONSTITUTION

The most important factor in having a flock of sound, vigorous turkeys that have good constitutions is the breeding back of the flock. Selection of the healthy, well-matured turkeys before selling any of the birds for market will aid in building up a disease-resistant flock. The ancestry of

[1] Received for publication April 15, 1937.

[2] Associate Veterinarian in the Experiment Station.

[3] Graybill, H. W. Blackhead and other causes of loss of turkeys in California. California Agr. Exp. Sta. Cir. 291:1–14. 1925.

[4] Van Es, L., and J. F. Olney. Diseases of poultry—their nature and control. Nebraska Agr. Exp. Sta. Bul. 290:1–110. 30 figs. 1934.

the breeding stock should be considered; birds from a parent that had some defect, such as a pendulous crop, crooked toes, or a curved spine should always be avoided. A poult that has come through the season without any setback will serve much better for propagation than the poult that has had several setbacks. Marking the prospective breeders early in the season for later culling to the number needed insures a large group of birds that meet with the requirements. Before being finally selected for a breeding flock, each individual should be examined for defects and discarded if abnormal in any way.

When buying hatching eggs or day-old poults, one should inquire carefully into the source of the stock to be purchased. To meet increasing competition, hatcheries must furnish the kind of poults required by their customers. The purchaser of poults should therefore demand stock from disease-free breeding flocks that measure up to the principles just discussed.

ADEQUATE NUTRITION

An adequate diet is one that supplies all the essentials for normal growth. With any one essential food lacking or, even in some instances, over-abundant, the normal development will be hindered; and a diseased condition, directly or indirectly due to the faulty ration, may result. Whether or not heavy losses from death occur in such cases, slow development may cause as great a monetary loss as if the flock suffered from a heavy mortality. Some of the dietary disorders caused by faulty rations will be discussed under another heading.[5]

SUITABLE ENVIRONMENT

The term "environment" refers to the surroundings in which the turkeys must live. Necessarily, this environment varies with the methods of rearing. The practice used in some sections of California of hatching and rearing with turkey hens on large range areas furnishes an entirely different type of environment from that furnished by the so-called "artificial" method of incubator hatching of eggs and brooder rearing of poults. Furthermore, the range rearing of poults is in contrast to the confinement method. In any case, the relation to disease depends on the ability of the environment to aid nature in combating disease. Dryness, drainage, amount of sunshine, nearness to chickens or other fowls on the same ranch, location in respect to other ranches, type of soil, and shelter facilities are examples of environmental factors that may influence the disease problem on any turkey ranch.

[5] For information concerning rations found suitable for turkey rearing, the reader is referred to: McFarlane, N. L., W. E. Lloyd, and Grant Merrill. Turkey raising in California. California Agr. Ext. Cir. 58:1–60. Revised 1934.

ERADICATION AND CONTROL OF TRANSMISSIBLE DISEASES

Transmissible diseases are those commonly called infectious or contagious. Once established, they may cause heavy losses. Examples are blackhead, fowl typhoid, fowl cholera, pullorum disease, paratyphoid, and coccidiosis. Each infectious disease has its specific germ, which must be introduced into the body of a susceptible bird before it can cause the disease. The two general ways of introducing infectious diseases into a flock are natural and mechanical carriers.

Natural Carriers.—The most serious carriers of infections are turkeys or other birds which have apparently recovered from the disease in question but which still retain the germs in some part of the body where they continue to multiply and to be eliminated. Among the diseases known to be transmitted by apparently normal carriers are blackhead, coccidiosis, fowl typhoid, and pullorum disease. Removing natural carriers from the flock and premises is the most effective way of preventing a recurrence of an outbreak. Different methods of accomplishing this end exist; but one, common to all diseases, is absolute isolation of the adult breeding flock from the growing flock.

Disposing of all the turkeys on the premises and buying day-old poults from reliable hatcheries for each year's flock is an excellent method of eliminating natural carriers. Such a system of management necessitates a division of the turkey industry into two classes: the utility, or meat-producing, and the breeding. This division will be for the betterment of the turkey industry; for the meat producer will be able to obtain a better class of poults from the breeder who makes it his business to improve his stock constantly.

The producer of hatching eggs will have the problem of isolating from his adult flock and other fowl the poults kept for replacements. Brooding of poults with turkey hens is conducive to disease spread, since a carrier hen is a continual source of the infection. Coccidiosis and blackhead, for example, are impossible to control if infected turkey hens are used to brood poults. No matter what sanitary precautions are taken to prevent these diseases in turkey-hen-reared poults, the continual elimination of germs by the mother hen will defeat the sanitary methods used.

Unfortunately, carriers of the more common diseases of turkeys cannot be detected by simplified tests that are practicable. The agglutination tests for carriers of fowl typhoid and of pullorum disease are exceptions and may be of value in flocks known to be infected. The tuberculin test for detecting tuberculosis carriers, though reliable for chickens and other livestock, has not proved efficient for turkeys.

Chickens may be carriers of many diseases common to both turkeys and chickens. In some instances—for example, in blackhead—they are fairly resistant, whereas turkeys are highly susceptible. Turkeys and chickens can be successfully reared as penmates or in adjoining yards provided both species are free of disease; but the chances that chickens may carry blackhead or other diseases are too great to risk.

If chickens are reared on the same ranch with turkeys, care should be taken to reduce to a minimum the possibility of infection of one species by the other. An irrigation ditch running from a chicken yard to a turkey yard is a common method of spreading disease. Equally dangerous is the ditch or stream passing through one poultry ranch and flowing through the turkey pens of an adjoining ranch.

Mechanical Carriers. — Mechanical carriers include all means by which germs are accidentally carried from place to place: man, animals, wild birds, insects, dust storms, moving vehicles, and flowing streams. Disease prevention includes the prevention of infection by such carriers.

Man is the worst offender. The attendant who cares for a flock of adult turkeys that contain coccidiosis carriers is the principal carrier of the disease to young poults. As experimental work at this station has shown, an attendant may carry coccidia on the soles of his shoes at least ½ mile. Sterilized feed trodden by attendants who have visited yards known to contain coccidiosis carriers has proved to be contaminated and, when given to susceptible birds, has produced fatal cases of coccidiosis. Thus, if adult turkeys are to be kept on the same ranch with poults, great care must be taken to prevent spread of the disease from the adults to the poults by attendants. This precaution applies to other diseases.

Visitors, especially other turkey growers, feed salesmen, and service men from other ranches, are the principal offenders aside from the attendant himself. The turkey grower should avoid visiting his neighbor's ranch if disease is known to be present. Visitors should be cautioned about entering the houses and yards. The feed dealer's or the poultry buyer's truck, and the borrowed spray tank that has been making the rounds of the turkey ranches may be sources of disease. The used feed sack, the poultry crate that has not been thoroughly cleaned and disinfected after being sent to market, and the hoe or scraper that is used in the pens of adult carriers and then in the brooder house without being cleaned, are other possible sources of disease.

Since carcasses and offal from birds killed for table use can be classed as possible sources of disease, such material should be burned or buried deep. Contaminated soil and water polluted by sick birds and thrown into streams even at some distance from the ranch are other sources.

Hospitals and hospital yards may be important in spreading disease to different pens or houses on a ranch. Sick birds from several pens congregated in one hospital pen or house and later taken back to their respective quarters may not only carry back the condition for which they were removed but one or more diseases contracted while in the hospital. For this reason hospital pens are not advocated. Birds removed for treatment should be kept near their respective units.

Wild birds, dogs, cats, rodents, and insects are difficult to incriminate as mechanical carriers, but they are possibilities and should be kept away whenever possible. Certain wild birds susceptible to turkey diseases are potential natural carriers.

SANITATION

Sanitation may be defined as the means and measures directed toward establishing and maintaining an environment in which it is safe for animals to exist. The factors considered on the preceding pages are important adjuncts to any sanitary program. Especially important is the elimination of carriers. Other factors to consider are houses, yards, water supplies, and food.

Houses and Yards.—Although few turkey growers in California need housing facilities for adult turkeys, brooder houses are growing in favor as a means of rearing poults to the ranging age. The first step in the sanitation of brooder houses is the original construction. Ease of cleaning and disinfection, proper isolation of each unit in case of the multiple-pen type, separate entrances for each unit, sanitary water and feeding systems, and rodent-proof feed-storage containers should be considered when building a brooder house. Continuous with the cement floors of the houses, cement yards should be constructed with sides and with the proper slope to permit cleaning and washing of one pen without danger of getting water and refuse into the adjoining pens. Facilities for cleaning the individual houses and yards can be arranged by having a gate in the front entrance of each yard. A gravel drainage area in front of the yard system or a cement drain to take off the excess water after washing the yards is desirable. Wire sun porches and wire platforms are also an aid in preventing disease.

The number of birds on a given area, either in the brooder house or on the range, may influence the livability percentage to a marked degree. Overcrowding means more work in keeping the surroundings clean and dry; it also increases the problem of feeding and ventilation in brooders. These factors indirectly lower the resistance of birds and facilitate spread of disease.

Yards or ranges for growing turkeys should be maintained free of all infections and infestations. Chickens should never be reared alternately in yards with turkeys. For the confinement method of rearing

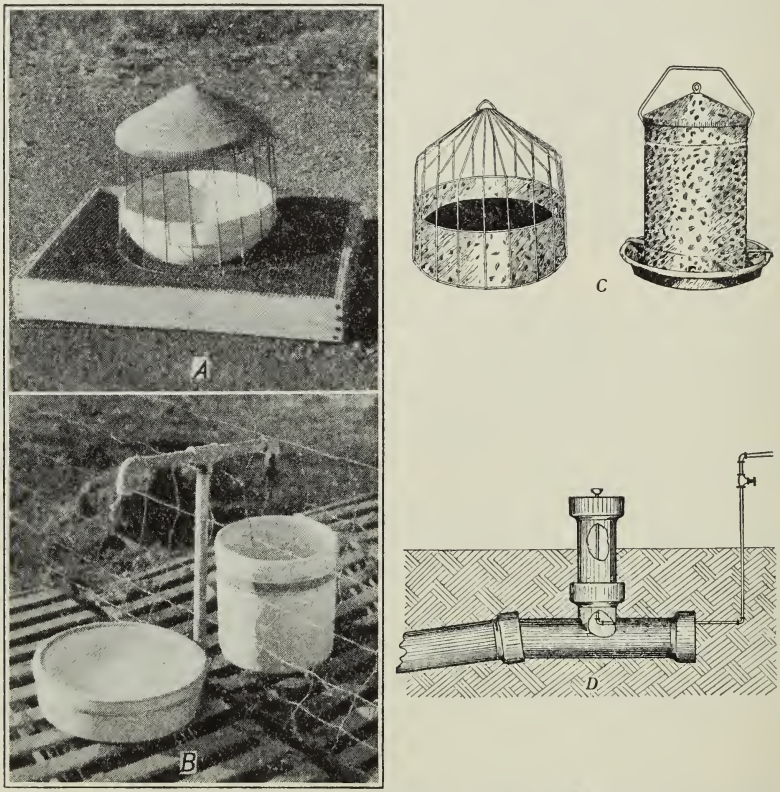

Fig. 1.—*A*, A sanitary type of waterer; placing the watering device on a wire platform aids in preventing spread of disease. *B*, A sanitary watering system for use with running water; the overflow passes into a drainage pit below the lath platform. *C*, Two types of commercialy made galvanized waterers suitable for poults; these should be set on wire platforms to insure dry surroundings as in *A*. *D*, The "Van Es" type of water fountain. It provides for a continuous flow of water in the bubbler and for passage of overflow into the tile drain. The drinking cup is placed 8 inches above the ground, is kept automatically cleansed, and can be regarded as strictly sanitary. (*D*, Courtesy of L. Van Es, University of Nebraska.)

turkeys, rotation of runs is recommended. In large range areas, as used in some sections of the state, rotation of runs is impossible; but feeding grounds and feeding areas can be moved at least twice a week as an aid in preventing accumulations of manure and litter, where the greatest danger of disease lies. Good drainage that prevents the formation of stagnant pools in yards is necessary. The probability of intro-

ducing disease is directly related to the amount of parasitic invasion. If moisture is not present, only the more resistant organisms can remain alive and infective. Good drainage, such as is found on sandy or gravelly soil, aids in keeping infections at a minimum, because of the dilution factor of rains. Dry, hot regions having an abundance of sunshine, such as exist in many California areas, aid in reducing the possiblity of contamination and therefore in preventing disease. The range method, which provides enough ground so that birds can be moved frequently to clean areas, likewise helps.

Water Supply.—Since the water supply is no better than the poorest water available, all sources other than those known to be clean and safe from contamination should be removed. The best type of water fountain is of no value in preventing disease if it is allowed to overflow and to form a stagnant pool. The immediate area around the permanent fountain or drinking place should be filled in for several inches with gravel, or the container should be set on a screened platform to insure a dry area, which will help to prevent the spread of disease. In houses or in yards, wherever possible, an automatic watering system with proper drainage for disposal of the surplus is recommended. Figure 1 illustrates types of watering devices that are recommended. Many other types of ready-made sanitary water equipment are on the market.

Streams and irrigation ditches as a source of water are safe provided they come from uncontaminated sources, are not stagnant, and are flowing at a fair rate of speed. *Pools of stagnant water from overflowing or leaking canals or water from ditches that are not flowing cannot be considered reliable.* Since poisoning from salt water and alkali water has been reported, such waters should always be avoided.

Pure, fresh, clean water is the most palatable. If well protected from contamination by body wastes, soil, and feed, it far surpasses the same water doped with panaceas. Birds do not like most of the common antiseptics recommended for drinking water; often they avoid water because of this dislike. Frequent changing of water or the use of a sanitary drip or cup system is usually preferable to the use of antiseptics.

Feeds and Feeding Methods.—Feed as a mechanical means of carrying infection has already been mentioned. In addition, feed may directly transmit fungus diseases, botulism, and possibly paratyphoid infections. For these reasons, one should purchase the best feed and protect it from dampness and from all sources of infection. Moldy feed should never be given to turkeys.

Several outbreaks of mycosis originating from contaminated milk containers have been observed by the author. Failure to wash and scald

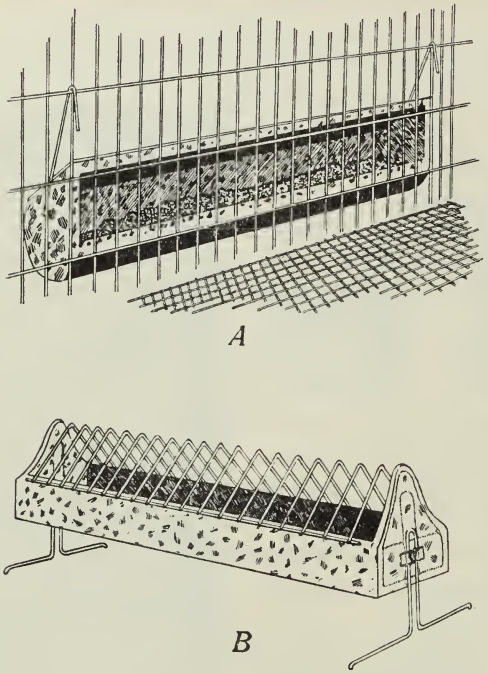

Fig. 2.—*A*, A practical type of metal feeder designed for hanging on the outside of the wire fence enclosure of a wire-floored sun porch. It can be filled without going into the pen. *B*, A type of metal feed hopper with wire guards that aid in keeping the feed clean. Note that this type of a feeder can be raised or lowered to accommodate different sizes of birds.

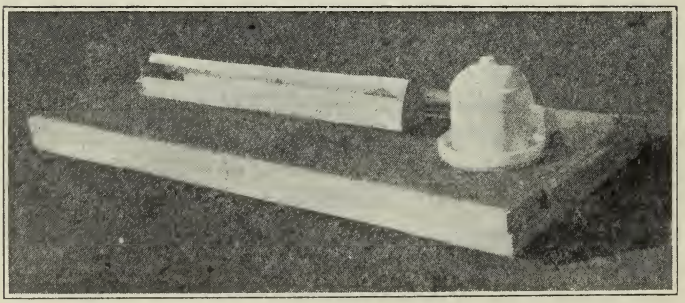

Fig. 3.—Feed hopper and waterer suitable for young poults. The wire platform aids in keeping the adjacent area in a sanitary condition.

daily the cans used for transporting milk from the dairy to the turkey range has been the most common cause. Improper care of semisolid milk has been another source of mycosis.

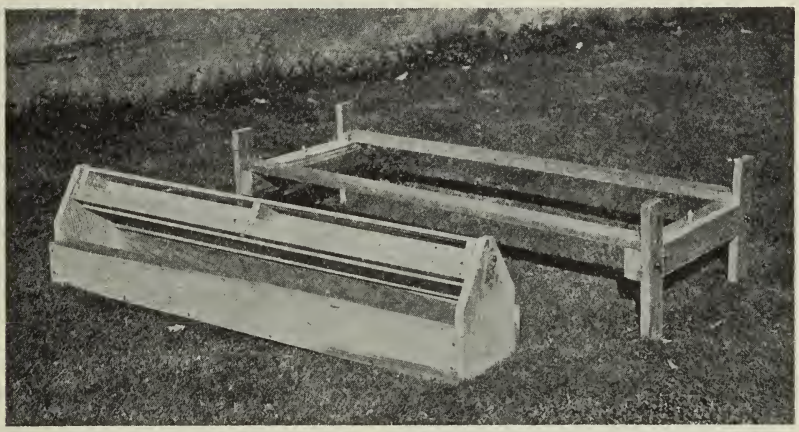

Fig. 4.—An open-type feed hopper for growing poults. A swivel-type cross-piece prevents roosting on the hopper. (From Bul. 476.)

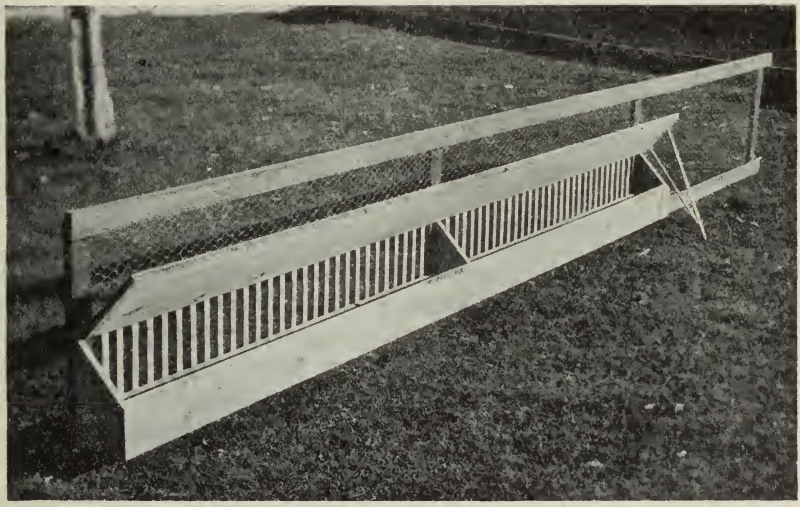

Fig. 5.—Feeder for grain, mash, or chopped greens. It has the advantage of permitting feeding from the outside of the pen. (From Agr. Ext. Cir. 58.)

Safeguarding the feed against fecal matter and other refuse by using properly constructed feed hoppers is a necessary procedure in the sanitary program; and cleaning the hoppers scrupulously at frequent intervals is important. *Sweepings from the floor of the feed house should*

never be given to young growing stock, because of the danger of refuse carried from the adult flock on the attendant's clothing and shoes. If feed is mixed on the ranch, mechanical mixing is much superior to hand-mixing and reduces the chance for accidental contaminations. Feed hoppers that aid in preventing disease are illustrated in figures 2–5.[6] Many suitable types of metal hoppers are on the market.

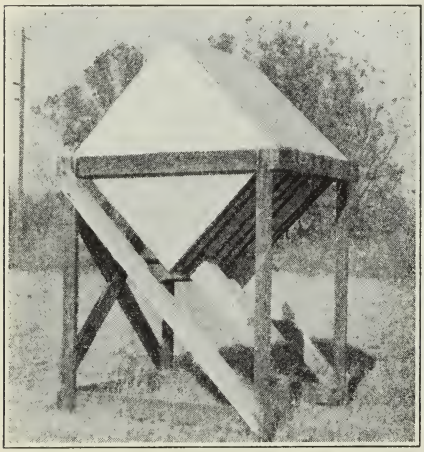

Fig. 6.—Bin for temporary bulk storage of grains and mashes on the range. The use of this or a similar type of storage tank will help to prevent contamination of feed by rodents and birds. (Designed by T. I. Storer, photograph used by permission.)

Excess feed scattered around yards attracts rats, mice, and birds, which are all potential carriers of disease. Proper storage of feed in rat-and-mouse-proof bins will thus aid in disease control. Sacked feed that must be stored can be kept reasonably free from rats and mice by careful attention to rat-proofing storage houses.[7] Metal garbage cans with covers make suitable bins for temporary storage of feed in brooder houses and in yards. These should be placed outside of the yards whenever possible. Another type of outdoor storage tank is shown in figure 6.

DISINFECTION AND DISINFESTATION

Disinfection destroys the microbic causes of disease; disinfestation, the higher forms of life that are causes of disease. Destruction of coccidia, the pullorum-disease germ, and the blackhead germ are examples of disinfection. Lice, ticks, and worm eggs are disease-producing parasites whose destruction comes under the head of disinfestation. The products used for destroying organisms are known as disinfectants and disinfestants according to their use.

In a sanitary program for controlling turkey diseases, disinfectants and disinfestants are used principally to destroy parasites outside of,

[6] Other methods may be found in McFarlane, N. L., W. E. Lloyd, and Grant Merrill. Turkey raising in California. California Agr. Ext. Cir. 58:1–60. Revised 1934.

[7] The principles of rat and mouse control are given in: Storer, T. I. Control of injurious rodents in California. California Agr. Ext. Cir. 79:1–55. 1933.

Methods for rat-proofing buildings and premises may also be found in: Silver, James, W. E. Crouch, and M. C. Betts. Rat proofing buildings and premises. U. S. Dept. Agr. Farmers' Bul. 1638:1–26. 1930.

or on the body of, the host. Eliminating the host is the only effective means of freeing flocks from the parasites harbored within the body of the carrier. Remedies for removing parasites from within the body of the host cannot be considered here, since one can rarely eliminate and destroy all the parasites by treatment.

Disinfection.—Disinfection is important in reducing the amount of infection in flocks where carriers exist and, after an outbreak of disease, in destroying the enormous numbers of parasites eliminated. Disinfection at frequent intervals during an outbreak helps to reduce the amount of infection and thus to prevent further spread. It may be accomplished by mechanical, physical, or chemical means. Success depends on the nature of the environment, the character of the disease germs to be destroyed, and the method to be used. The procedure must fit the special conditions on the ranch. In most cases a combination of the three means gives the best results.

Cleaning, before the final application of chemicals, is essential in any disinfection program. Used alone, it will not result in disinfection; but, if carried out properly, it will reduce the number of germs and will render disinfection by chemicals more efficient. Water or weak soapsuds used to flush the walls of a brooder house may serve, however, as a medium for growth of germs and, unless collected and not allowed to run over the ground, may spread infection. The following steps are suggested for cleaning and disinfecting brooder houses and cement runs before poults are put in them:

1. Settle the dust by spraying lightly with the disinfectant to be used. This procedure avoids undue scattering of germs by the dust.

2. Haul all litter and droppings to a well-isolated portion of the ranch where there will be no danger of contact with the turkeys. Never spread litter or droppings on the land being used for ranging turkeys or chickens. If infection is known to exist, burn the litter.

3. Remove all movable equipment to the cement run or to a cleaning floor or platform if one is available.

4. Scrub the walls, floors, and equipment with hot lye solution made by adding 1 pound of lye to 20 gallons of hot water. An old broom can be used to apply the lye solution; care should be taken to prevent the fluid from getting on the hands and face. About 1 hour after its application, the lye should be rinsed off with hot water.

5. Spray the walls, floors, and all equipment with a good disinfectant of the concentration recommended by the manufacturer. Use a compressed air sprayer for applying the disinfectant, and cover every part of the building or equipment.

6. Allow time for drying before putting the house and equipment into use again. The fire gun may be an aid in drying if the time is limited.

Certain types of hovers and brooder-heating equipment are not easily washed and disinfected by this method because of the danger of injuring them. The formaldehyde gas method recommended for disinfecting cabinet types of incubators may be used for such equipment if a gas-proof room is available.

The recommendations given above should be followed each time a brood of poults is removed from a pen and before a new lot is added. The same methods are helpful in cleaning and disinfecting any house used for poultry.

After the poults are put in the brooder house, frequent dry cleaning without disinfection is sufficient. This procedure is recommended because moisture promotes the development of coccidia, the cause of coccidiosis. The fire gun may be an aid in drying up areas around water fountains and feed hoppers. (See "Dry Heat," p. 21.)

Disinfestation.—Mechanical or physical means of hindering the development of parasites or destroying them are probably as important as chemical means. Cleaning the yards of all refuse, removing litter and droppings frequently, and constructing the houses so as to prevent the harboring of ticks, lice, and mites are examples of mechanical methods. All methods of fly control—trapping, cleanliness, and removal of breeding places—indirectly aid in tapeworm disinfestation. Oil sprays for mite and tick control and nicotine sulfate or sodium fluoride for lice are chemical means of destroying parasites.

The methods recommended for cleaning and disinfection are also applicable in the disinfestation program. Yards are best treated by frequent cleansing and by rotation. The former dilutes the amount of infection or infestation and allows the sun better opportunity to exert its influence on the remaining parasites. Rotation of runs at regular intervals allows the sun and the other natural elements to free a given area of parasites and disease germs. No satisfactory cheap disinfestant for the soil has been found.

Plowing of the yards is not recommended under California conditions unless necessary for weed control or unless a crop-rotation system is combined with the turkey-rearing program. Plowed yards soon become dusty, tend to become jutted with holes that collect water during rains, and are harder to clean than yards that are to be left unplowed.

DISINFECTANTS

The number of chemicals sold as disinfectants is so great that the prospective buyer is often bewildered when he goes to purchase a supply. Some are worthless: others are excellent disinfectants but have undesirable characteristics. Among the properties of an ideal disinfectant are (1) low cost per unit of disinfecting value, (2) ready solubility in hard water, (3) relative safety to man and animals, (4) efficient deodorization, (5) easy availability, (6) nondestructibility to utensils and fabrics, (7) stability when exposed to air, (8) absence or minimum of objectionable and lingering odor, (9) effectiveness for a large variety of germs. Obviously, no one chemical will have all these properties; but the list will serve as a guide. Though far from being a satisfactory means of evaluating a product, the phenol coefficient gives one a fair estimate of its effectiveness.

Many disinfectants of similar composition are sold under different trade names. Before buying a product under an unfamiliar trade name, one should compare types and values with a well-known product. The directions for dilution given by the manufacturer should be followed in making up a disinfectant for use. These directions are usually based on the concentration of the product; and by comparing the dilution factor of two disinfectants that have other properties equal, one can determine the relative cost of the two. For instance, if one disinfectant can be used at the rate of 1 part to 40 parts of water, while another has to be used at the rate of 1 part to 20 parts of water, the first, other things being equal, is worth twice as much as the second.

Phenol, or Carbolic Acid.—Phenol is a chemical substance obtained from coal tar. In its pure form it occurs as colorless needles having a characteristic odor familiar to everyone. It is usually sold in water solutions and is too expensive for general use. A 2 per cent solution is a useful antiseptic for wounds; but stronger solutions, as a rule, are caustic. This is the chemical used as a basis for determining the phenol coefficient of disinfectants.

Crude Carbolic Acid.—Crude carbolic acid is a mixture of phenol, cresol, and certain impurities. Its usefulness varies directly with the percentage of cresol, which has a higher disinfecting value than phenol. As its composition is uncertain, it cannot be classed as a desirable disinfectant for general farm use. It is sometimes used in oil mixtures for controlling mites and lice in poultry houses; but, since the oil is as effective without the crude carbolic acid, there is no reason for combining the two.

Cresol.—Cresol is a thick yellow or brown liquid, mixable with water but only slightly soluble. It forms the basis for a large number of the best commercial brands of disinfectants, made by combining cresol with a soap base.

Compound solution of cresol (liquor cresolis compositus U.S.P.), the most refined of the saponified cresol solutions, is composed of cresol 500 grams, linseed oil 350 grams, potassium hydrate 80 grams, and water to make 1,000 grams. Saponified cresol solutions are more effective and less toxic than phenol, can be used in low percentage solutions, are reasonably priced, and are fairly stable in the presence of organic matter; but they have the disadvantage of being soapy and of having the odor characteristic of the cresols. They can be recommended for general use on the farm.

Turkey growers who need large quantities of disinfectants would do well to buy them to conform with the specifications of the United States Department of Agriculture Bureau of Animal Industry.[8] Saponified cresol solutions applied under supervision of the Bureau must contain not less than 50 nor more than 53 per cent total phenol and not less than 21 per cent by weight of soap; they must form clear solutions when mixed with water, and must be used in the proportions of 4 fluid ounces per gallon of water.

Coal-Tar Disinfectants (Sheep-dips.) — Coal-tar disinfectants are cresol products that form milky emulsions when mixed with water. They vary greatly in their solubility and disinfecting value and when used should be diluted according to the directions given by the manufacturer.

Chlorine Gas.—Chlorine gas is the basis of the disinfectants known as hypochlorites. The numerous brands of these products offered for sale vary in their disinfecting value according to their chlorine stability and their ability to liberate chlorine gas. They should contain at least 2.6 per cent by weight of available chlorine, the active disinfecting element of such products. Such solutions, if used according to directions, are highly efficient. Their chief disadvantage is the instability of the chlorine when exposed to air or organic matter. They are also quite expensive. Their principal use is for disinfecting limited areas such as incubators, small brooders, and water and feed containers. All surfaces

[8] The disinfectants recognized for official use are listed in: Mohler, J. R. Permitted disinfectants, revised list 1937. U. S. Dept. Agr. Bur. Anim. Indus. Cir. Letter 2010 (B.A.I. order 309) 1–4. (Mimeo). This may be obtained by writing to the United States Department of Agriculture Bureau of Animal Industry, Washington, D. C.

A list of the disinfectants offered for sale within the state, with their analyses, can be obtained from the Division of Chemistry, State Department of Agriculture, Sacramento, California.

to be disinfected with hypochlorite solutions must first be thoroughly cleaned in order to insure the greatest efficiency. Stock supplies should be kept in dark cool places, and the containers should be tightly sealed when not in use.

Chlorinated Lime.—Chlorinated lime, known as bleaching powder, is prepared by saturating slaked lime with chlorine gas. It should contain from 30 to 35 per cent of available chlorine. The Bureau of Animal Industry recognizes chlorinated lime containing at least 30 per cent available chlorine for official disinfection when used in proportions of 1 pound to 3 gallons of water. Products containing less available chlorine should be used in more concentrated solutions. The final dilution should contain approximately 1.2 per cent of available chlorine by weight. Fresh solutions must be prepared daily. All products containing chlorine must be handled with care; for free chlorine is destructive to fabrics, leather, and metal.

The use of chlorine on the turkey ranch is limited to disinfection of drains, water containers, and feed containers. Its instability makes it of doubtful value for general disinfection.

Quicklime (Unslaked Lime, Calcium Oxide).—The action of quicklime depends on the liberation of heat and oxygen when the chemical comes in contact with water. On the poultry ranch its use is limited to small yard areas that are damp and cannot be exposed to the sun, to the disinfection of drains and fecal matter, and to whitewashes. Adding chlorinated lime to quicklime at the rate of 1 pound to 40 gallons of wash increases its disinfecting value in whitewashes.

As quicklime has a caustic action, turkeys should be kept away from it until it has become thoroughly dry.

Lye.—Lye is an excellent cleansing agent, valuable in any disinfecting program. A 2 per cent solution of sodium hydroxide (soda lye) is a good disinfectant for many of the germs causing disease. Because of insufficient data on its disinfecting value against some of the common poultry-disease germs, however, it should be used primarily as a preliminary cleaning agent. Being a severe caustic, it should be handled with care.

Formaldehyde.—Formaldehyde is a gas, sold commercially in a 40 per cent solution with water under the name of formalin. For spraying it is used in a 10 per cent solution of formalin (that is, a 4 per cent solution of formaldehyde). Though a powerful disinfectant, it has many disadvantages, especially its volatility, penetrating odor, caustic action, and tendency to harden the skin—properties which make it disagreeable to apply. Its chief advantages are as follows: (1) it can be used as

a gas or vapor for fumigation of incubators or small rooms; (2) it is relatively nontoxic to animals and fowls; (3) it is an efficient disinfectant in the presence of organic matter; and (4) it does not injure utensils and spraying equipment with which it comes in contact.

Its use on the turkey ranch is limited to disinfection of brooder equipment, incubators, water and feed containers, and occasionally—during outbreaks—fumigation of clothing and small utensils that are difficult to disinfect by other means. Fumigation of brooder houses with formaldehyde is, as a rule, impractical because of the difficulty in getting them airtight.

Fumigation of incubators and incubator rooms is a practical procedure, in common use by hatcherymen. Most manufacturers have recommendations for their type of machine; and, when possible, their directions should be followed. When fumigating a room or an incubator, one must have the space airtight and the room temperature and humidity as high as possible. For most efficient disinfection of incubators, Bushnell and Brandly[9] recommend a wet-bulb thermometer reading of 85° to 95° Fahrenheit. Disinfection is uncertain in rooms having a temperature of less than 65° and a relative humidity of less than 60 per cent.

The two common methods of fumigating cabinet-type incubators (forced- or circulating-air types) are given below:

1. Formaldehyde gas is generated by mixing formalin (40 per cent formaldehyde) and potassium permanganate. For this purpose 35 cc of commercial formalin and 17.5 grams of potassium permanganate for each 100 cubic feet of incubator space are mixed together in an earthenware or enamelware vessel having a volume of four to five times the amount of material used. The vessel should be placed about 3 feet above the floor in the middle compartment of the incubator. The doors should be kept closed for at least 10 minutes to allow the gas to penetrate to all parts of the machine. Equipment for generating and introducing the gas through the intake parts of certain types of machine is obtainable from the manufacturers.

Compartment-type (still-air type) machines do not lend themselves to fumigation methods so well as do the cabinet types, but can be so disinfected by opening them and fumigating the room in which they are located.

2. Formaldehyde gas liberated from formalin-soaked cheesecloth is recommended by the Illinois Agricultural Experiment Station. Before

[9] Bushnell, L. D., and C. A. Brandly. Poultry diseases, their prevention and control. Kansas Agr. Exp. Sta. Bul. 247:1–106. 1929.

disinfection, the incubator must be thoroughly dry-cleaned. Approximately 20 cc of formalin is used for each 100 cubic feet of incubator space. A saturated cloth large enough to carry the formalin without dripping is suspended under or near the circulating fans, and the formalin allowed to evaporate. This method is said to be as efficient as the first and is less expensive.

Formaldehyde can be successfully used when eggs are in the incubator without injury to the eggs. It is therefore of especial value for disinfecting between hatches in large incubators where poults are hatching at short intervals of time. Fumigation with formaldehyde kills the common disease germs in the incubator, but not within the egg nor within the body of the hatching poult. Its principal use, therefore, is in disinfecting incubators between hatches and, in some instances, during the early stages of a hatch. Before fumigation of incubators during the hatching period, advice should be sought from one familiar with the procedure to determine the possible need and methods. In general, fumigation of hatching poults is not recommended.

Copper Sulfate (Bluestone).—Although copper sulfate and other salts of copper have a marked poisonous effect upon some of the lower forms of life, they are not considered good general disinfectants. Copper sulfate is a good destroyer of algae and certain fungi and may prove of some value in outbreaks of fungus diseases. As experimental work done at this station has shown, copper sulfate of a greater concentration than 1 part in 500 of water may be toxic when given as the only source of drinking water. Turkeys do not like copper sulfate solutions of any concentration and will seek other water supplies if they are available. A 0.5 per cent solution may be of value for disinfecting feed hoppers, water fountains, and areas around these in fungus-disease outbreaks.

Copper sulfate should not be used either for general disinfecting purposes or for use in drinking water except when recommended by a veterinarian or a diagnostic laboratory for controlling a specific disease which has been definitely diagnosed.

Potassium Permanganate.—Potassium permanganate depends on its rapid oxidizing property for its disinfecting value. Although it has little usefulness as a general disinfectant, certain properties make it convenient as an antiseptic for drinking water. It is inexpensive, and when it has lost its disinfecting power, it turns brown. As it corrodes metals, it must be used in earthenware or wooden vessels. One level teaspoon of potassium permanganate for each gallon of water will aid in reducing the chance for the spread of disease, but it has no medicinal

value. Potassium permanganate solutions lose their antiseptic power so quickly in the presence of organic matter that they are useless for mouth or crop treatment.

Sodium Orthophenylphenate.—This substance has only recently been recommended as a general disinfectant. It has no objectionable odor, is relatively nontoxic, is highly efficient for most disease germs, and is readily soluble in water. It may be purchased in the form of a grayish, brownish, or white powder or flakes, which must be kept in a closed container to prevent deterioration. It is now sold under several trade names, which are included under the Bureau of Animal Industry list of permitted disinfectants. It gives best results when applied hot. According to trials made by the United States Department of Agriculture, it is effective for mite control and lice control.

Iodine.—This disinfectant, though effective, is too expensive for general use. Tincture of iodine is a valuable antiseptic for skin wounds but should not be used internally.

Iodine suspensoid, a colloidal iodine suspension in water, has been reported by the Michigan Agricultural Experiment Station to be effective against bacteria, coccidia, and worm eggs. It is recommended by the manufacturer for disinfecting brooder-house floors and equipment. Its use, however, is limited because of its high cost. As iodine preparations, like many other good disinfectants, are quickly destroyed in the presence of organic matter, a thorough cleaning must precede their use.

Mercuric Chloride (Bichloride of Mercury, Corrosive Sublimate).—Although a powerful disinfectant, mercuric chloride is limited in usefulness by its cost, toxicity, and marked corrosive action on metals. It is commonly used in a 1–1,000 dilution with water. Because its value is markedly lowered by the presence of organic matter and because it has certain other undesirable properties, it cannot be recommended for disinfection of litter or houses. Many other disinfectants, almost as efficient and less poisonous, are preferable for use on the turkey ranch.

Sunlight.—The sun's direct rays are the best disinfectant known. Since, however, the material to be treated must be in thin layers and exposed to the direct rays, this method of disinfection is limited to yards and to utensils that can be thoroughly cleaned before being exposed. The construction of most poultry houses prevents efficient disinfection by the sun. A cement platform fully exposed to the rays makes a convenient place for treating movable equipment. If properly constructed with a drain, such a platform can be utilized as a washing and disinfection rack.

Hot Water.—Hot water adds to the efficiency of any disinfectant

and, if applied in the form of boiling water or live steam, is effective without the addition of any chemical. Live steam must be applied directly to the part to be disinfected.

Dry Heat.—Dry heat in the form of a flame is effective provided the flame comes into contact with the germ to be killed. According to recent experiments by Stafseth and Camargo,[10] the fire guns commonly used on poultry farms are not highly efficient as a means of disinfection. They may be of some value in drying up the floors and walls after the use of watery solutions of disinfectants and also in drying up damp areas around water and feed containers after a dry cleaning of brooder-house floors. *All methods involving direct flame are, however, dangerous fire hazards.*

DISINFESTANTS

Disinfestants, sometimes called parasiticides, destroy animal parasites such as lice, mites, ticks, and fleas. Their use is recommended only as an adjunct to a properly conducted sanitary control program. Many disinfectants are also destructive to lice, mites, and other similar parasites, provided they come in contact with the parasite. Many, however, are useless as disinfestants.

Crude Oil, Distillates, and Similar Cheap Oils.—Petroleum oils are excellent and cheap destroyers of lice, mites, and ticks. There is no advantage in adding disinfectants to oils for lice and mite control; the oil itself is as effective, and oil lowers the value of a disinfectant. Since the oil must come into direct contact with the parasite, refuse must be removed and all hiding places made accessible before the application.

Carbolineum, a commercial product with good penetrating properties, is very effective for controlling mites and lice within the poultry house. Creosote oils of the penetrating types used for termite control are helpful in lice, tick, and mite control if not too expensive.

Nicotine Sulfate.—A 40 per cent solution of nicotine sulfate, such as is sold under the trade name of Black Leaf 40, is in general use for control of lice on chickens. Its action depends on a volatile substance that penetrates the feathers of the birds when it is painted on the perches just before they go to roost. The method is not well adapted to control of lice on turkeys under California rearing conditions, where the perches are usually placed out of doors.

Sodium Fluoride.—This, either as a dust or as a dip, is effective for ridding birds of lice. For use on turkeys, the dusting method is probably the most desirable. It consists of rubbing a pinch or two of the powder

[10] Stafseth, H. J., and F. Carmargo. On the disinfection of poultry houses by means of fire guns. Jour. Amer. Vet. Med. Assoc. 39(n.s.):162–67. 1935.

into the parts most often infested with lice (on the tail, under the wings, on the neck and head, and on the breast). Such treatments should be repeated in about two weeks if the birds are badly infested. Turkey hens used for hatching and brooding poults should be treated before being placed on the eggs and again just before the eggs hatch.

REMEDIES

The most successful turkey growers in California are those who feed adequate diets consisting of simple ingredients, give the birds all the fresh, pure water they will drink, and spend little or no money for panaceas. The number of specific and useful remedies is limited, and turkey growers should question the merits of advertising literature. The Food and Drug Administration of the United States Department of Agriculture has published the following list of turkey diseases for which there is no commonly known specific remedy: fowl typhoid, fowl cholera, fowl pox, coccidiosis, pullorum disease, sinusitis (roup, swell head), and blackhead. Salesmen who try to sell remedies for these diseases should have their attention called to this fact.

The periodic use of laxatives such as Epsom salts is of questionable value. Too often growers who believe that medication of drinking water and the use of Epsom salts at frequent intervals are necessary to maintain the health of their birds overlook certain fundamental principles of feeding, watering, and management which, if carefully observed, would usually eliminate the need for medication.

Dual-purpose worm remedies that are claimed to be efficient for both roundworms and tapeworms have no place in the turkey-management scheme in California, because roundworms in turkeys are of uncommon occurrence in this state. A flock should never be treated for any species of worms until a large number of the birds have been examined. A few worms in one or two birds do not justify treatment. In no case should tapeworm remedies be given to the entire flock before testing out the drug on a few birds. This is necessary because most tapeworm remedies contain kamala, which varies in its toxicity for turkeys.

The giving of remedies should be supervised by someone adequately trained in the art of treatment rather than by the average feed salesman, remedy salesman, or others with little or no training in veterinary medicine. Remedies of merit are listed under the treatment of the specific disease for which they are recommended. They should not be used for other diseases unless advised.

HANDLING AN OUTBREAK OF DISEASE

A daily inspection of the flock is essential. At the first signs of the birds' becoming droopy, losing their appetite, or in any way appearing abnormal, one should start looking for the possible cause. Every disease outbreak should be considered infectious until the contrary is proved.

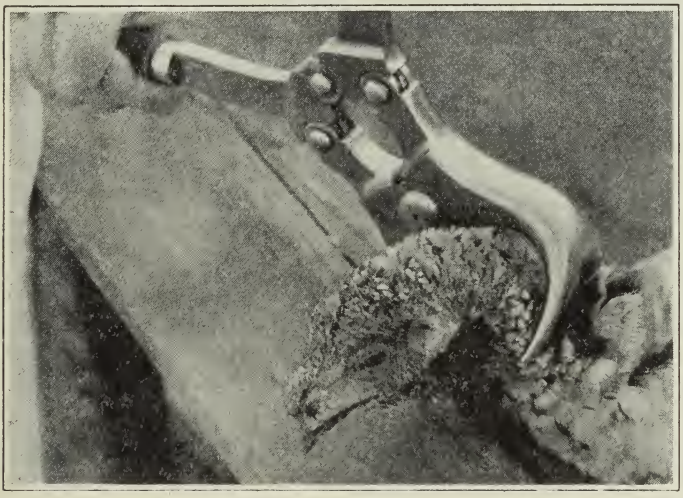

Fig. 7.—Use of Burdizzo forceps in killing a turkey. When brought into a closed position carefully the jaws separate the vertebrae and sever the spinal cord and jugular vein without breaking the skin.

From the first appearance of abnormalities in a flock, the following suggestions should be observed:

1. Isolate all abnormal birds. The best method is to remove the healthy-looking individuals and put them in cleaned and disinfected quarters or on ground that has not been used for turkeys for several weeks. Be sure that all the feed and water containers are thoroughly cleaned and disinfected before being transferred to the new quarters.

2. If the cause cannot be readily determined, secure the services of a veterinarian or have a diagnostic laboratory examine a few of the typical sick specimens.[11]

3. Kill hopelessly sick birds by breaking their necks to avoid shedding of blood and thus prevent the spread of infections that are present in the blood stream. A convenient tool for the purpose is a Burdizzo forceps like that used for castrating lambs (fig. 7).

[11] The State Department of Agriculture maintains free diagnostic laboratories at 9th and L Street, Sacramento; 627 F Street, Petaluma; 1451 Mirasol Street, Los Angeles; and Zoölogical Hospital, Balboa Park, San Diego.

4. Burn or bury dead birds. If buried they should be placed deep enough to insure their not being dug up by dogs or other animals.

5. Thoroughly clean and disinfect all houses and equipment. If the affected birds are in yards, these should be cleaned of all refuse to allow the sun's rays to aid in disinfecting all parts.

6. Keep fresh water before the birds at all times. The water containers should be thoroughly washed and disinfected at least once daily. Antiseptics in the drinking water are of questionable value and may cause turkeys to seek other sources of water supply much less desirable than pure untreated water. Stagnant pools or irrigation ditches should be fenced off so the birds cannot use water from them.

7. Thoroughly clean and disinfect all feed hoppers daily.

8. Thoroughly inspect the food to determine the possible presence of decayed fish or meat scraps, spoiled milk, moldy grain, poisonous weeds, or other sources of possible trouble.

9. If diarrhea is present, administer a mild laxative, such as stock mineral oil given at the rate of 3 quarts per 100 pounds of mash or bran for a period of three days. If Epsom salts are used, the amount should not exceed 1 pound to each 1,000 pounds of turkeys; many turkey growers make the mistake of giving too large doses. Milk flushes, though satisfactory for certain disease conditions, may cause severe losses in others. It is not desirable, therefore, to give milk in quantities for medicinal purposes until a definite diagnosis has been obtained.

10. Avoid sudden changes of feed. If the feed is the cause of the trouble, a new diet is warranted; but any changes should be made by gradually increasing the new formula. As a rule, reduction of the protein level of the ration is desirable during an attack of enteritis, a common manifestation in most of the ordinary diseases of turkeys. The addition of bran to increase the bulk of a feed and the use of a so-called meal method of feeding will often aid in stopping a mild case of enteritis which might cause severe losses if untreated. In these cases the mineral-oil treatment is also valuable.

11. Avoid tonics, medicated powders, and other remedies until after obtaining a reliable diagnosis. All remedies should be given under the direction of someone skilled in therapeutics. Remedy salesmen are, as a rule, not qualified diagnosticians; and not too much faith should be put in their advice. This statement holds for many feed salesmen. Often turkey growers are led to believe that their birds are suffering from some mysterious disease when the cause is apparent to a trained person. Once the veterinarian has made a diagnosis, the treatment and practices he advises should be given a fair trial.

12. The convalescent stage of any disease is the most important one. Poults die from lack of feed and water in a very short time. Getting a poult to eat after it has been ill, even for a short time, is often a very difficult task. It must be accomplished however, if the mortality is to be reduced to a minimum. Feeding small quantities of mash at frequent intervals often aids in restoring feeding habits. The use of small amounts (not to exceed 5 per cent) of molasses in bran or bran plus the regular mash, sometimes serves as an appetizer if other methods fail. Plenty of fresh water and succulent greens should be given. Do not use medicated mashes or tonics except on the advice of a veterinarian or someone that is thoroughly familiar with the situation on your ranch.

DIETARY DISEASES[12]

The dietary diseases described in this section are those that are most commonly observed and whose origin is known. Other turkey diseases that may in the future prove to be related to feeding practices are classified under the miscellaneous group.

VITAMIN-A DEFICIENCY DISEASE

(Avitaminosis-A)[13]

Vitamin A, known as a fat-soluble vitamin, is found in many fish oils, in all green leaves, yellow corn, yellow carrots, and some other yellow or red root crops. Yellow corn, carrots, alfalfa, and fresh green feed of any type are the most common sources for turkeys. Since turkeys require considerably more vitamin A than do chickens, they are more susceptible to vitamin-A deficiency disease.

Symptoms.—Poults fed a vitamin-A free diet from the time of hatching begin to show symptoms within three to four weeks, according to the amount of storage in their bodies at the start. They appear listless, walk unsteadily, and have a tendency to sit with sagging wings, drooping heads, and closed eyes. Later symptoms include watery eyes, swelling of the third eyelid (nictitating membrane), and nasal discharge. A milky exudate, followed by a white cheesy exudate, appears in the eyes and head sinuses if the poult lives for any period after showing the first symptoms. The nictitating membrane has a dry, rough appearance, and the surface may be covered with finely divided powdery exudate. When observed early in the morning, many poults will be found with their eyes closed by a sticky exudate adhering to the lids. Figure 8 shows, for comparison, a poult and a chick, both exhibiting typical symptoms.

[12] This section was written in coöperation with Thomas H. Jukes.

[13] For a more complete discussion see: Hinshaw, W. R., and W. E. Lloyd. Vitamin-A deficiency in turkeys. Hilgardia 8(9):281–304. 1934.

The course of the disease in poults is very short, and 100 per cent mortality occurs within two weeks after symptoms appear if vitamin A is not supplied.

In older birds receiving inadequate amounts of vitamin A, the symptoms are similar but more pronounced, probably because of the chronicity of the disease. In many instances symptoms that cannot be differentiated from swell head (sinusitis) are observed. It is, therefore, highly desirable in all outbreaks of cold and swell heads in turkeys to eliminate the possibility of vitamin-A deficiency when making a diagnosis.

Fig. 8.—A five-week-old poult and a six-week-old chick, both showing typical symptoms of vitamin-A deficiency. (From *Hilgardia*, Vol. 8, No. 9.)

Autopsy Findings.—Lesions are confined principally to the upper digestive tract and to the head. They consist of swollen caseated glands (pustules) in the posterior part of the mouth (figs. 9, *A*, and 10), the upper esophagus and the crop and an involvement of the sinuses of the head (fig. 51). The bursa of Fabricius, an accessory pouch-like organ present only in young poults and located dorsal to the rectum and having an opening into the cloaca (fig. 9, *C*), is usually filled with a white, flaky exudate. Urate deposits on the intestines, heart, and lungs, and swollen kidneys filled with urates, common in chickens suffering from vitamin-A deficiency, have not been observed.

Control and Prevention.—Control and prevention consist in furnishing sufficient vitamin A in the ration. This can be supplied by feeding the birds all the fresh green alfalfa or similar succulents that they will consume. These can be in the form of alfalfa, clover, kale, lettuce, or any other leafy green vegetable. Yellow carrots are an excellent source of vitamin A and, if finely chopped, are relished by turkeys.

A good grade of alfalfa meal may be substituted but, since it varies greatly in potency, it should be purchased whenever possible on the basis of carotene content. According to experimental work done at this

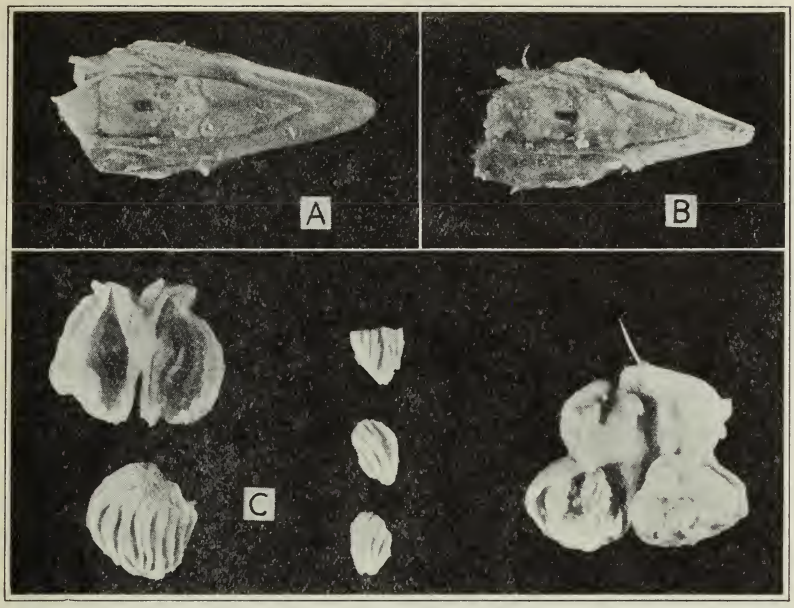

Fig. 9.—*A*, Floor of mouth and pharyngeal region of a 40-day-old turkey that died from A-avitaminosis. *B*, Same of a 45-day-old chick; note the large number of pustules in *B* as compared with *A*. The specimens are typical for the two species. *C*, Sagittal section of bursas of Fabricius and caseous plugs characteristic of A-avitaminosis in young turkeys and chickens; the left bursa was from a poult; the right, from a chick; the middle specimens are typical caseous plugs from bursas taken from chicks. (From *Hilgardia*, Vol. 8, No. 9.)

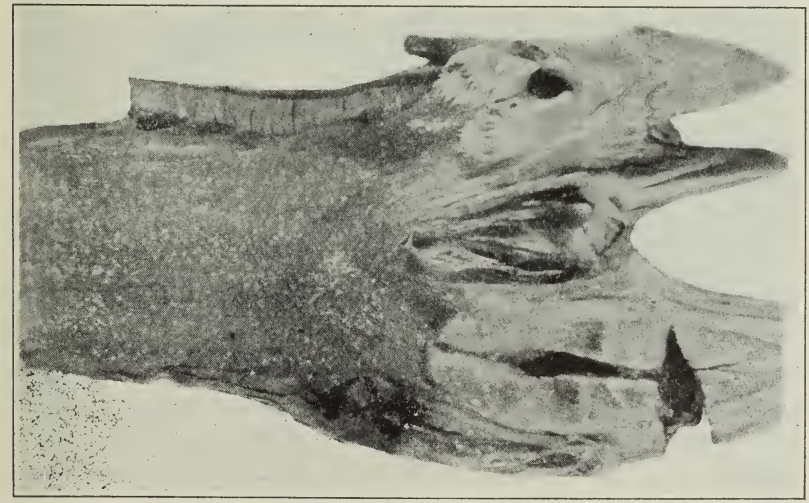

Fig. 10.—Portion of head and esophagus of a turkey hen laid open to show the pustular lesions in this part. (From *Hilgardia*, Vol. 8, No. 9.)

station, an 8 per cent level of alfalfa meal containing at least 0.013 per cent carotene is required to grow turkeys to maturity if no other source of vitamin A is supplied.

RICKETS

(Vitamin-D Deficiency)

Rickets, a bone disease affecting all animals and birds, is caused by failure to receive a proper balance of vitamin D and minerals.

Symptoms.—Leg weakness, awkwardness of gait, softness of the beak and leg bones, and ruffled, unkempt feathers are characteristic. The affected poults fail to gain weight and finally die if the balance of minerals and vitamin D is not corrected.

According to Scott, Hughes, and Loy,[14] poults receiving a diet deficient only in vitamin D will develop symptoms in 18 to 20 days, and 100 per cent mortality will occur within 30 days after hatching.

Autopsy Findings.—Softness of the bony structures and beading of the ribs are the most common autopsy findings. A definite diagnosis depends on a chemical analysis of the bones or blood or upon the "line" test for rickets.

Prevention and Control.—Baird and Greene[15] found that from 60 to 70 units (as specified by the United States Pharmacopeia) of vitamin D per 100 grams of feed (270 to 315 U.S.P. units per pound) were required for the growth of turkeys to twelve weeks of age. Chickens fed similar rations required only 18 units per 100 grams of feed. Careful attention should be paid, therefore, to supplying poults plenty of sunlight or an adequate amount of vitamin-D-tested fish oil in the ration. The oil should have been tested with chicks, as a rat test is of little value for a poultry oil. As the amount of fish oil to be used depends on its potency (number of chick test units per gram), the recommendations of the manufacturer should be followed in determining the amount of a particular brand.

It is a good practice to add a chick-tested fish oil to the ration of the breeding flock to insure an adequate storage in the egg for development of the embryo and for starting the poult after it is hatched. Since sunshine cannot be depended upon during the brooding season, fish oil should be a regular part of the ration until the poults are put out on the range. Whether or not fish oil should then be continued depends on the amount of sunshine available. A proper balance of minerals, especially calcium and phosphorus, is also essential in preventing rickets.

[14] Scott, H. M., J. S. Hughes, and H. W. Loy. Rickets in young turkeys. Poultry Sci. 11:177–80. 1932.

[15] Baird, F. D., and D. J. Greene. The comparative vitamin-D requirement of growing chicks, turkeys, and pheasants. Poultry Sci. 14:70–82. 1935.

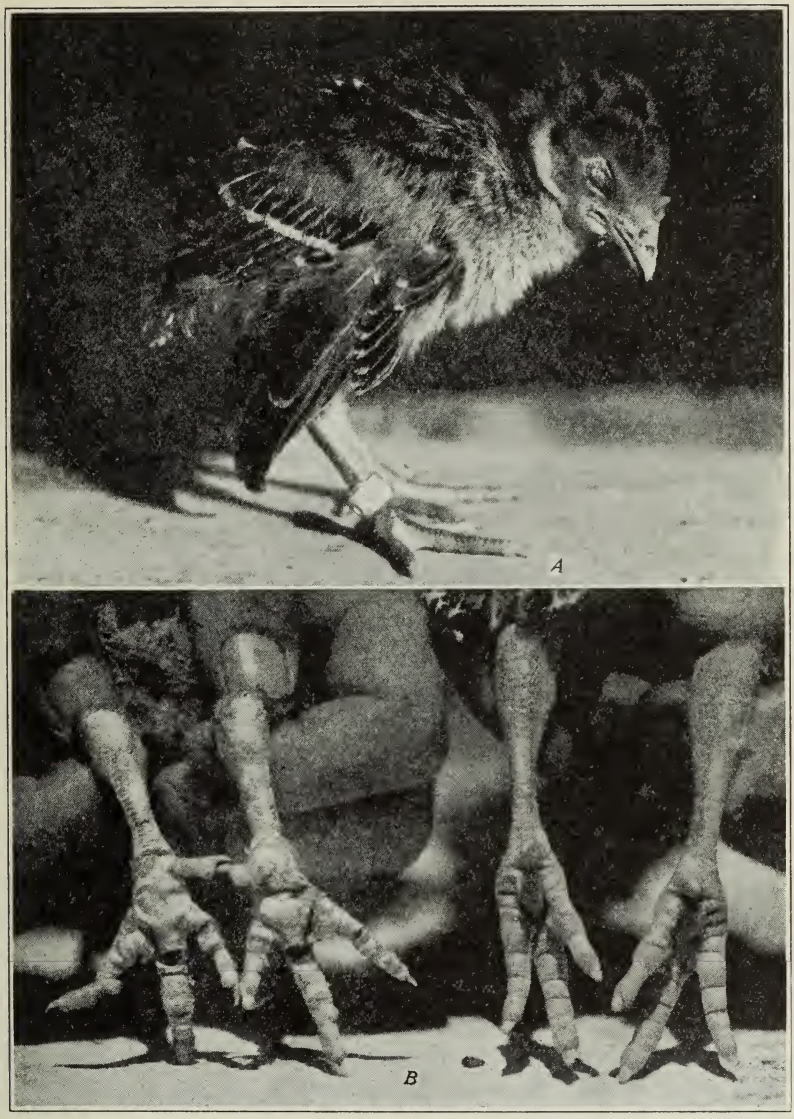

Fig. 11.—*A*, A 29-day-old turkey after 17 days on a flavin-deficient diet. Note the encrusted eyelids, mouth, and nostrils. The feet were not showing lesions at the time this picture was taken. *B*, Legs and feet of two 3-week-old turkeys. The ones on the left are from a poult fed a flavin-deficient ration from hatching time. The other ones are from a poult fed the same basal ration, with flavin added. Note the dryness of the skin of the legs and the marked ulceration of the foot pads in the diseased specimen. In these cases the skin of the legs and feet peel at the slightest touch. (Courtesy of T. H. Jukes.)

DIETARY DERMATITIS

It has been found at this station[16] that the group of water-soluble vitamins formerly known as "vitamin G" contains at least two factors which are essential to life for turkeys. The first of these is call "flavin" or "lactoflavin." Poults receiving a ration deficient in lactoflavin grow slowly and develop symptoms of dermatitis as shown in figure 11.

The symptoms of dermatitis in poults consist of a sore mouth and encrustations at the corners of the mouth; diarrhea, resulting in an inflamed encrusted vent; thickened eyelids that tend to stick together; ragged feathers; and a listless, unthrifty appearance. In advanced cases the feet may also be involved (fig. 11, *B*). Growth is very slow, and mortality is high.

Feedstuffs that are good sources of flavin are: fresh or dried greens, alfalfa meal, dried milk, and dried whey. In plants, the leaves are the richest sources of flavin.

The second of the so-called "vitamin-G" group is a vitamin which prevents dermatitis in chicks. It has been tentatively called the "filtrate factor." It does not appear to prevent dermatitis in turkeys; but if poults are placed on a diet deficient in this vitamin, they grow slowly and many of them die in a short time. The "filtrate factor" is present in moderate to fair amounts in most poultry feeds. Cane molasses is a good source of this vitamin, *but it is not advisable to feed more than 5 per cent of molasses because of its laxative action.*

SLIPPED TENDON

(Perosis, hock disease, spraddle legs)

Slipped tendon in turkeys (fig. 12), which may cause considerable mortality, is similar to, if not identical with, the condition of chickens commonly called "slipped tendon" or "perosis." The deformity is permanent and cannot be corrected by treatment.

Several factors are concerned in slipped tendons, the most important of which is probably too much phosphorus in the ration. Certain types of meat scrap contain too much phosphorus in the form of bonemeal. Four per cent of phosphorus (9 per cent of phosphoric acid, P_2O_5) is enough for a meat scrap to contain. An inherited tendency to develop the condition and too close confinement without roosts may also be aggravating factors.

[16] Lepkovsky, S., T. H. Jukes, and M. E. Krause. The multiple nature of the third factor of the vitamin-B complex. Jour. Biol. Chem. 115:557–66. 1936.

Lepkovsky, S., and T. H. Jukes. The response of rats, chicks and turkey poults to crystalline vitamin G (flavin). Jour. Nutrition 12(5):515–26. 1936.

A dietary factor which tends to prevent slipped tendons from developing has been demonstrated in rice bran, wheat bran, wheat middlings, and wheat shorts. Recent work by Wilgus, Norris, and Heuser[17] indicates that the mineral element manganese may also be a factor. Manganese salts are poisonous in ordinary amounts, but it was found by these in-

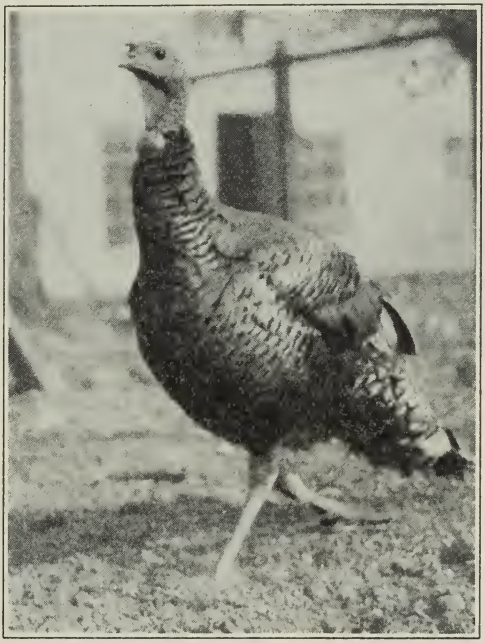

Fig. 12.—An advanced case of slipped tendon in a mature turkey. Note the rotation of the right leg at the hock joint.

vestigators that very small traces (0.003 per cent) were helpful in preventing slipped tendon in chicks. The requirements for turkeys have not yet been reported.

FUNGUS DISEASES

Fungus diseases, caused by molds and yeasts, occasion considerable mortality in turkeys in this state. The most important are aspergillosis, favus, and moniliasis.

ASPERGILLOSIS

(Brooder pneumonia, mycotic pneumonia, pneumo-mycosis)

Aspergillosis, a respiratory disease, is caused principally by *Aspergillus fumigatus,* although some other molds of the same genus may at times

[17] Wilgus, H. S., L. C. Norris, and G. F. Heuser. The role of certain inorganic elements in the cause and prevention of perosis. Science 84:252–53. 1936.

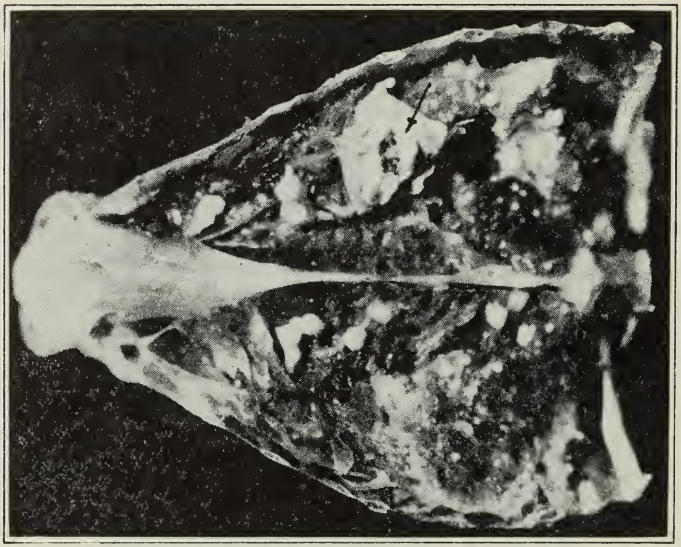

Fig. 13.—Lungs of turkey showing typical caseous nodules seen in the early stages of aspergillosis. Note also irregular lesion with center darkened by aerial hyphae of the fungus, denoted by the arrow.

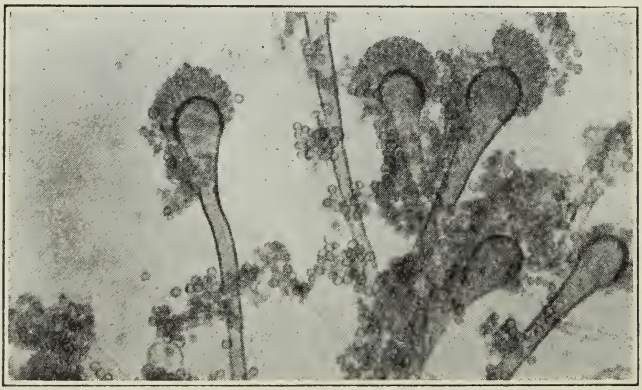

Fig. 14.—Microscopic appearance of aerial hyphae of *Aspergillus* from a specimen like that seen in figure 13. (× 920.)

be responsible. *A. fumigatus* is widely distributed in nature and is pathogenic for many animals, including man. In young poults kept on contaminated litter, it produces a pneumonia with heavy mortality. Infected older birds may suffer from pneumonia or air-sac infection.

Symptoms.—The symptoms depend on the seat of infection. Lesions in the mouth, trachea, or bronchi produce hoarseness, heavy breathing,

and sometimes rattling in the throat. Birds suffering from air-sac infection alone may not show any symptoms. As the disease progresses, dullness, labored breathing, and emaciation may be seen. Death probably results from either toxemia or asphyxiation. The mortality varies but is usually greater in brooder poults than in older birds.

Autopsy Findings.—Diagnosis is readily made in advanced cases. The lungs and air sacs are the principal seats of infection, but the disease may extend into the peritoneal cavity or into the air passages of the bones (fig. 13). The kidneys, liver, and spleen may be affected by direct contact from the air sacs. Yellow, semiliquid, or caseated masses in the air sacs and lungs, with buttonlike ulcers attached to the mucous membranes, are common. In the early stages these buttonlike ulcers appear as round, yellowish-white masses attached to the membrane. In advanced cases a greenish mold turf may be seen over the surfaces of the infected areas and in the convex depressions of the ulcers, especially in the air sacs. Final diagnosis depends on identification of the mold. The fungus can be readily demonstrated by microscopic examination of specimens that have been treated with 10 per cent sodium or potassium hydroxide and by culturing on suitable media. A careful examination of the convex surface of the buttonlike lesions will often reveal aerial hyphae, and seedings from these will usually insure a pure culture (fig. 14).

Prevention, Control, and Treatment.—Careful selection of grain and litter is essential in preventing this disease. Access to musty, moldy strawstacks should be avoided. A common source of the infection is semisolid milk from barrels that have been improperly cared for. If used, semisolid milk should always be kept covered with water to prevent mold growth over its surface.

Improperly kept drinking fountains used for dispensing milk have also been found to be a source of infection. One outbreak observed by the writer was associated with contaminated milk cans. The inside of the lids of the cans used for transporting milk was found to be covered with a fine mold growth; the owner had washed and scalded the cans daily, but thought it unnecessary to clean the lids. The storage barrels for the milk were also heavily infected.

The areas around feed hoppers and watering places are fertile fields for the growth of molds. Unless a permanent yard system is used, frequent moving of feed troughs and watering places is advisable. Placing feed containers and watering fountains on screened elevated platforms helps to prevent turkeys from picking up molds that develop in such places. Drainage is advisable with areas where water is liable to stand after rains.

Control is best accomplished by removing the cause. A careful search should be made for mold in the litter, the feed, and the feed and water containers. Daily cleaning and disinfection of feed and water utensils with a 0.5 per cent copper sulfate solution will aid in eliminating the infection. Spraying of the ground around the containers with chemical solutions may be advisable if it is impossible to change feeding areas frequently. In outbreaks, a 1–2,000 solution of copper sulfate in place of all drinking water may be used to aid in preventing the spread through this means, though it should not be relied upon as a preventive to be used continually.

The deep-seated nature of the disease renders treatment of little avail. *Extreme care should be used in handling and disposing of sick birds, because of the possible danger of transmitting the disease to the attendant.*

FAVUS

Favus is a chronic skin disease caused by a fungus, *Achorion gallinae,* and characterized by whitish areas about the exposed skin parts of the head. It is not common in California. Since man is susceptible, care should be taken to prevent transmission if an outbreak occurs.

The disease is generally mild and sporadic in nature. It may last in a flock for several months, but few losses directly traceable to it are experienced.

Symptoms.—The white powderylike spots which characterize the disease usually appear first around the beak. Thence they spread to the wattles, dewlap, and caruncles, and in extreme cases to the feathered portions. The fine pin-point white spots finally coalesce and may cover a considerable area. As the fungus spreads and grows, a piling up of the threads occurs, and a thick, crustlike area may result.

Prevention, Control, and Treatment.—Removal and disposal of all infected birds is recommended. It is well to move the flock to new quarters when practicable. After removal of infected individuals, the premises must be thoroughly cleaned and disinfected.

Treatment should be attempted only in very valuable birds. A mixture of 6 parts of glycerine and 1 part of iodine applied locally is recommended for the infected parts of the head.

As favus may be infective for man, great care should be taken in handling outbreaks.

MONILIASIS

(Mycosis of the crop, thrush)

Moniliasis is a disease of the upper digestive tract of both chickens and turkeys caused by yeastlike organisms belonging to the genus *Monilia*. Jungherr[18] was probably the first in the United States to observe the

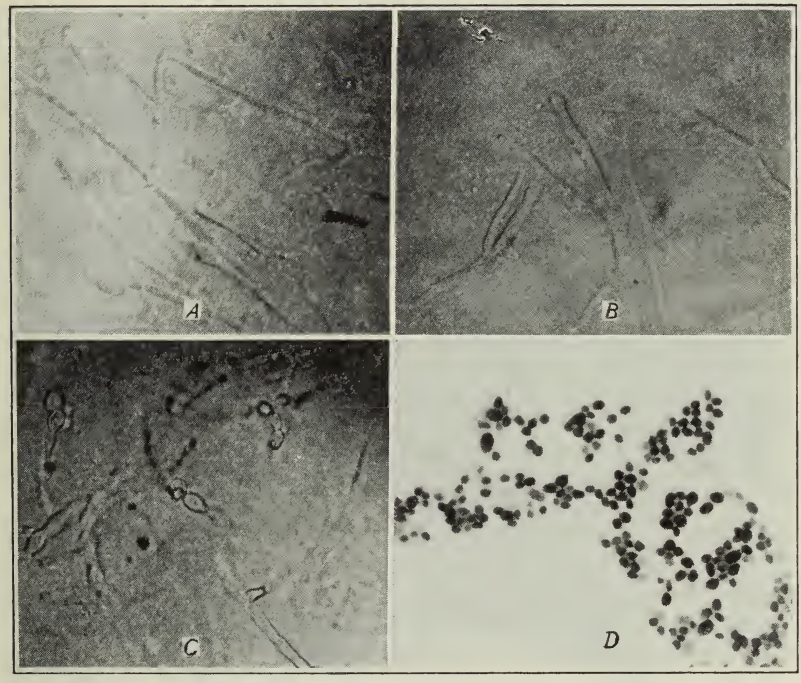

Fig. 15.—*A, B,* Microscopic appearance of scrapings from the crop of a turkey affected with moniliasis. *C,* Microscopic appearance of liver-tissue smears from a rabbit infected with a culture of *Monilia* isolated from a turkey. *D,* A 48-hour culture isolated from the crop of a turkey; stained by Gram's method. (×650.)

disease in chicks; Gierke[19] has reported an outbreak of a thrushlike disease occurring in turkeys in California during the summer of 1931; and the writer[20] has described the results of studies on several outbreaks in turkeys and chickens. The organism isolated by the writer from these outbreaks resembled *Monilia albicans* and was pathogenic for turkeys,

[18] Jungherr, Erwin L. Observations on a severe outbreak of mycosis in chicks. Jour. Agr. Research 46:169–78. 1933.

[19] Gierke, A. G. A preliminary report on a mycosis of turkeys. California State Dept. Agr. Mo. Bul. 21:229–31. 1932.

[20] Hinshaw, W. R. Moniliasis (thrush) in turkeys and chickens. World's Poultry Congress 5th Proc. Paper 97:1–8. 1933.

chickens, and rabbits. Figure 15 shows examples of the microscopic appearance of the organisms growing in tissues and on a cultural medium.

The disease is a common cause of losses in poults from two weeks to five months of age in all sections of the state. Usually it has been associated with some debilitating condition, which probably aids the fungus in becoming established. The losses vary greatly, but the mortality may be as high as 60 per cent.

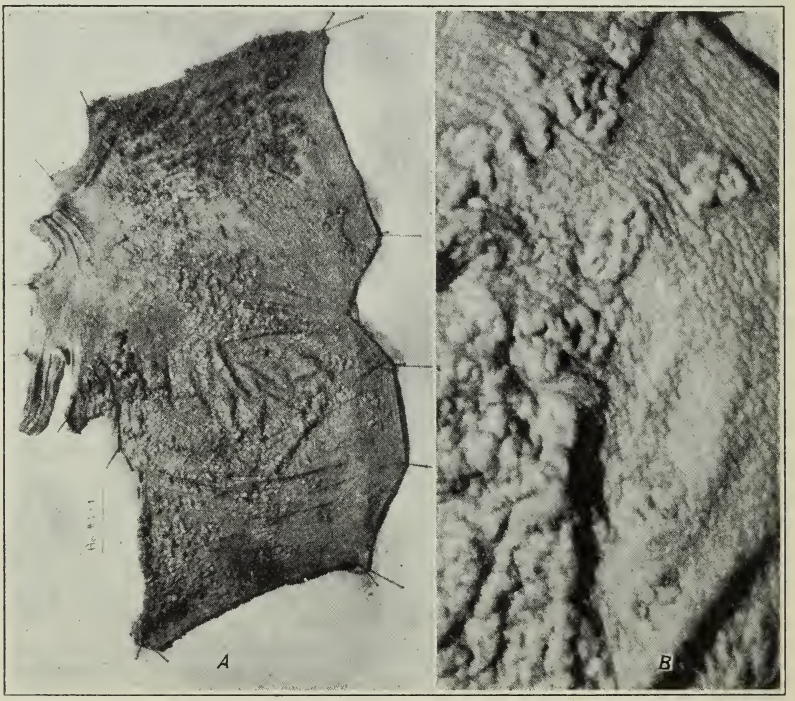

Fig. 16.—*A*, Crop of a turkey suffering from moniliasis; *B*, enlarged section of *A*; note the raised, piled-up exudate which tends to form roselike masses.

Symptoms.—As most of the outbreaks observed have been complicated with some other pathologic condition, specific symptoms have been difficult to determine. More or less constant symptoms have, however, been listlessness, loss of appetite, tendency to stand around with heads drawn back on the shoulders, and a sunken appearance of the chest. The eyes and sinuses appear sunken, and the heads haggard.

Autopsy Findings.—The crop has been the most common seat of infection. Fungi have also been demonstrated in scrapings from the mouth, infraorbital sinuses, upper and lower esophagus, proventriculus, and gizzard, but never from the intestines. Cultures of the causative organ-

ism have been obtained from all of these organs and in addition from a lung abscess and from a skin abscess.

In the more acute cases, as well as in the milder cases, there is seen a catarrhal to thick mucoid exudate with a tendency to form a pseudomembrane. Soft, raised, whitish-yellow ulcers having a roselike appearance and scattered over the surface, at times coalescing to form a solid mass of piled-up exudate (fig. 16), characterize the more chronic cases. These lesions have been variously described by turkey growers and others as having a "turkish-towel-like" or "curdy" appearance. In early or mild cases the mucous membrane may appear parboiled. The lesions are easily scraped from the surface, leaving the mucous membrane abraded and injured to a greater or less extent, according to the severity of the infection.

In most cases the crops either have been empty or have contained a small amount of thick slimy exudate. Cultures of the fungus have been readily obtained in nearly pure state by washing off the surface exudate and planting a fairly deep scraping on 2 per cent dextrose agar, glycerine dextrose agar, or on Sabouraud's honey agar of a pH of 6.0 to 6.4. The colonies are large enough and so characteristic that unless molds interfere, no difficulty is experienced in fishing individual colonies for purification.

Prevention, Control, and Treatment.—Because of the nature of the disease and its frequent association with other diseases common in crowded quarters and in flocks suffering from some form of malnutrition, sanitation and proper diet are important factors in control. Removal of birds to clean and thoroughly disinfected quarters, together with the daily cleaning and disinfection of feed and water containers, has helped to reduce losses.

Copper sulfate solution of a 1–2,000 dilution substituted for all drinking water for a few days is a helpful control procedure. It should be remembered, however, that turkeys do not like this solution; if any other source of water is available, they will not touch it. Use of crockery or wooden fountains is recommended when copper sulfate solutions are used. A convenient method of making up approximately a 1–2,000 dilution of copper sulfate solution is given below.

Stock solution: Dissolve 1 pound of copper sulfate (bluestone) in 1 gallon of soft water (rain water or distilled water). If soft water is not available add 1 teaspoon of concentrated hydrochloric acid or 1 cup of vinegar to the water before adding the copper sulfate. It may be necessary to heat the mixture to dissolve the copper sulfate. Store in a glass bottle.

To make a 1–2,000 dilution: Add 1 tablespoon of the stock solution to each gallon of water. It is necessary to acidify hard water by adding just enough vinegar or hydrocloric acid to prevent precipitation of the copper. The amount of acid will vary with the hardness of the water. Not over 1 teaspoon of hydrochloric acid should be added to each gallon of water. Substitute this solution for all drinking water. Do not leave any other water or milk in a place available to the turkeys, for they will not drink solutions containing copper sulfate if other liquids are available. Keep the solution of copper sulfate before the birds continually for at least a week after losses have ceased and flock improvement has been noted.

BACTERIAL AND VIRUS DISEASES

In this section will be included the common diseases of turkeys which are caused by bacterial agents. No attempt will be made to describe the various bacteria. In each case the causative organism is given if known, and the reader is referred to standard text books on bacteriology if descriptions are desired.

The single important virus disease, fowl pox, is also included in this section.

BOTULISM

Botulism is caused by a toxin produced by an anaerobe, *Clostridium botulinum*. Of the three types of toxins poisonous to man and animals, only A and C are known to affect fowls. The toxins are produced by the microörganism while growing in such substances as decomposing food, dead carcasses, and wet grain, and are transmitted to birds when the contaminated products are eaten. Although the disease is not prevalent in California, losses are heavy when it does occur.

Symptoms.—The most common symptom is a complete paralysis, which gives the disease its name, "limberneck." The birds sit around with their heads and necks on the ground or extended over the back (fig. 17), often in a comatose condition. In turkeys the feathers do not shed so readily as in chickens affected with the disease.

Autopsy Findings.—No specific lesions differentiate botulism from other acute diseases. The crop usually contains evidence that the birds have been eating spoiled food. Often fly maggots are present. The finding of the suspected food in the crop,together with the typical symptoms, is usually enough to diagnose the disease.

Prevention, Control, and Treatment.—Every effort should be made to prevent turkeys from obtaining foods that might harbor the botulism organism. Spoiled canned vegetables should never be given, for they are liable to contain botulinus toxin.

When the disease appears, all the birds should be moved to a new feeding ground and, if necessary, fenced in to prevent access to spoiled food. Sick birds should have plenty of shade. Their crops can be drained and flushed out with warm water with the aid of a rubber tube and a funnel or by the method shown in figure 49. Large doses of mineral oil or castor oil may help to get rid of the toxin in birds that have not gone into a coma. The cause of the trouble should be traced, and recurrence

Fig. 17.—Typical posture in botulism of turkeys.

prevented. In valuable birds polyvalent (mixed) botulinus antitoxin may be used. Information regarding this product can be obtained from veterinarians.

Persons handling turkeys suffering from botulism should keep in mind that botulinus toxin may affect man. Careful washing of the hands after care of the birds is suggested as a precautionary measure.

ERYSIPELAS

Recently Beaudette and Hudson[21] have described a disease in turkeys caused by the swine erysipelas organism, *Erysipelothrix rhusiopathiae*. This is the first case of the disease described in turkeys in the United States, although European investigators have reported erysipelas in various species of birds, including turkeys.

Another outbreak of the disease in the United States has been recently described by Madsen.[22] It is of interest that both the United States outbreaks have been on farms where sheep were being reared. In the out-

[21] Beaudette, F. R., and C. B. Hudson. An outbreak of acute swine erysipelas in turkeys. Jour. Amer. Vet. Med. Assoc. 41(n.s.):475–87. 1936.

[22] Madsen, D. E. An erysipelas outbreak in turkeys. Jour. Amer. Vet. Med. Assoc. 44(n.s.):206–8. 1937.

break reported by Madsen, there is evidence presented that the disease was contracted by the turkeys from sheep corral washings that had been deposited over the turkey range by rains.

The disease manifestations as described by Beaudette and Hudson were primarily those of a septicemia. The mortality was high, 200 out of a flock of 500 dying in 9 days. The symptoms observed were listlessness, drooping tails and wings, little or no diarrhea, and only slight loss of appetite.

On autopsy, irregular blotch hemorrhages were observed in the superficial muscles, the nasal passages were filled with a thick mucus, the livers were enlarged, congested, and friable. Catarrhal enteritis was evident, with some reddening of the mucosa of the large intestine. In most cases the spleens were enlarged, mottled, and friable, hemorrhages sometimes occurring. Other lesions occasionally found were hemorrhages in the pericardium, congestion of the kidneys and lungs, and rarely, browning of the lung tissue.

Since the disease is not uncommon in swine and sheep in United States, turkeys should be kept away from swine and sheep herds, at least in areas where erysipelas is known to exist. Suspected cases should be submitted to a diagnostic laboratory for confirmation. The precautions outlined on pages 23–25 are recommended.

FOWL CHOLERA

Fowl cholera is an infectious and contagious disease of turkeys, chickens, geese, and other fowl caused by *Pasteurella avicida*. Although the disease is not common among turkeys in California, an occasional outbreak is reported. As in fowl typhoid, the presence of chickens is usually associated with these outbreaks. The organisms isolated have been identical with those from chickens.

Symptoms, Course, and Mortality.—In many respects the symptoms of fowl cholera resemble those seen in fowl-typhoid outbreaks. They include increased thirst, loss of appetite, listlessness, a yellow watery diarrhea, and a rise of 2° to 3° F above the normal temperature. The heads appear blue to purplish and have a haggard, drawn appearance. A slimy to gelatinous exudate in the mouth and nostrils is not uncommon. The breast muscles become congested, and the skin appears pinkish.

The course of the disease is acute, heavy losses occurring within a few days and being followed by intermittent losses with periods of no losses. Symptoms may not be observed before death. In the later stages the birds may linger for several days before death. Very few sick turkeys recover. Reports of losses of from a few birds to over half of the flock are common.

Autopsy Findings.—The autopsy findings in turkeys are typical of those in chickens, though generally more pronounced. The breast muscles are congested, and the crop usually contains considerable food having a very sour odor. The heart is often enlarged, and the pericardium may be thickened and covered with a whitish-yellow exudate. Many pin-point hemorrhages (petechiae) are commonly found over the surface of the pericardial sac, the muscles of the heart, and the adjacent tissues. The pericardial sac may be filled with a yellowish fluid containing whitish-yellow flakes. The liver is never more than slightly enlarged. It is friable and somewhat pale and may contain many minute whitish abscesses that give it a mottled appearance. The spleen may be slightly enlarged or may show no alteration.

The lungs, if changed at all, will be congested; occasionally pneumonia may be present. The gizzard seldom contains much food, but the few contents present have a peculiar sour odor. In most cases the mucous membrane peels readily, and the muscle of the gizzard appears more red than normally.

The blood vessels of the mesentery and intestines are usually engorged with blood. The intestines lack tone and often show considerable evidence of hemorrhage, especially in the duodenum. The contents range from a semiliquid to a mucoid consistency. The feces are usually yellow to yellow-green.

Diagnosis.—Although symptoms, lesions, course, and acuteness may indicate the disease, bacteriological examination is necessary for a positive diagnosis. Fowl cholera must be differentiated from such acute diseases as blackhead and fowl typhoid and from poisoning. The color of the feces cannot be considered a diagnostic aid.

Prevention, Control, and Treatment.—Sanitation and hygiene play a most important rôle in prevention. As in the case of fowl typhoid, this disease may be prevented to a large extent by keeping turkeys separated from chickens and by following the general disease-preventive measures outlined on pages 1–25. None of the information available indicates that fowl cholera may be transmitted through the egg in turkeys. It is not a good plan, however, to keep for breeding purposes birds that have recently suffered from the disease.

Skidmore's[23] observations on the common housefly as a possible carrier emphasize the need for keeping turkeys well isolated from chickens or other fowls that might be suffering from the disease and for prompt destruction of all diseased birds. Burning instead of burial of dead birds

[23] Skidmore, L. V. The transmission of fowl cholera to turkeys by the common housefly (*Musca domestica Linn.*) with brief notes on the viability of fowl cholera micro-organisms. Cornell Vet. 22:281–85. 1932.

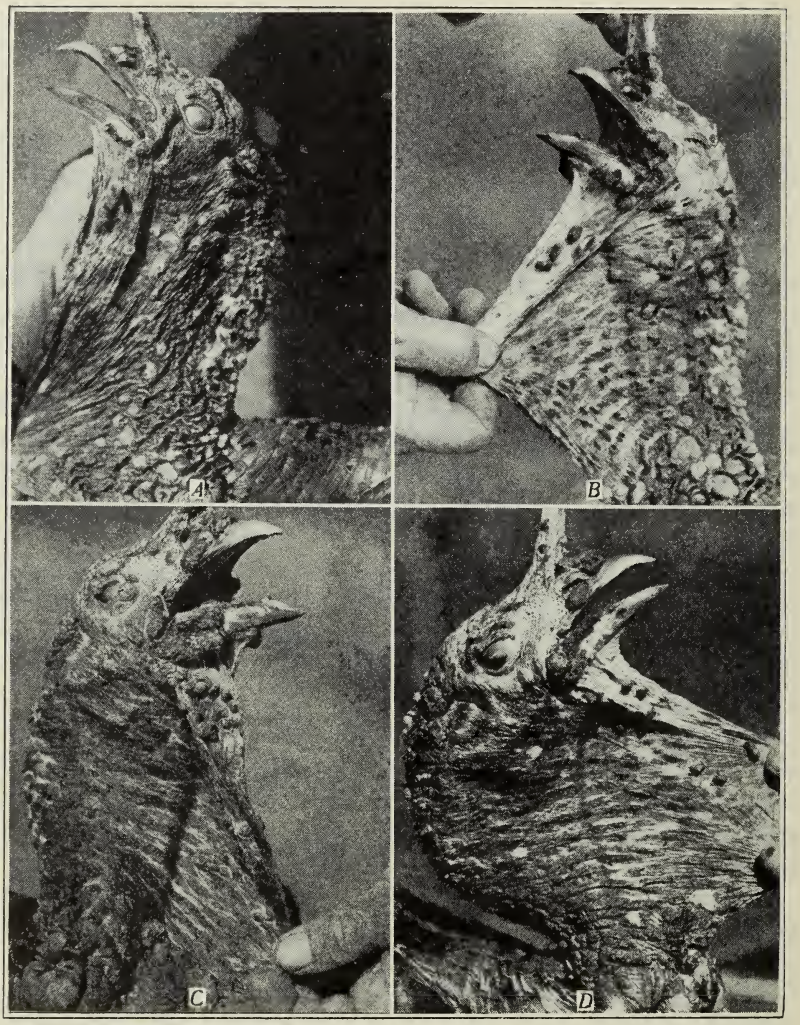

Fig. 18.—Development of fowl-pox lesions in a turkey; *A*, taken when the lesions were first observed; *B* and *C*, at 1 and 2-week intervals; *D*, taken four weeks after *A*. Within 10 days after *D* was taken the lesions had disappeared, but the bird remained blind in the left eye.

is recommended; otherwise the diseased carcasses, a source of infection, may be dug up by dogs and other animals. There is no known treatment.

FOWL POX

Fowl pox, a disease of the unfeathered parts of the birds' bodies, is characterized by the formation of pustules and scablike processes. It is caused by a filterable virus, pathogenic for chickens as well. Tested

Fig. 19.—Fowl-pox lesions in mouth and esophagus.

Fig. 20.—Fowl-pox lesions on the skin of breast of an adult turkey hen. The head parts were also badly affected.

strains of pigeon-pox virus have not proved so virulent for turkeys as have the numerous strains isolated from chickens and turkeys. Birds of all ages are susceptible, but one outbreak produces immunity for at least a year.

Symptoms and Autopsy Findings.—The first indication is the appearance of minute yellowish eruptions on the dewlap, caruncles, and other

head parts (fig. 18). They are soft and in this pustular stage easily removed, leaving an inflamed area covered with a sticky serous exudate. The corners of the mouth, the eyelids, and the mouth membranes (fig. 19) are commonly affected. The lesions enlarge and become covered with a dry scab or a wartlike mass of yellowish-red or brown color. The number of lesions depends on the virulence of the disease. In young poults, the head, legs, and feet may be completely covered with pustules. The disease may even spread to the feathered parts of the body (fig. 20).

Males often suffer more than females from the disease, probably because of their inclination for fighting, which spreads the infection through small lacerations.

The mouth parts, the tongue, the esophagus, and occasionally the crop may be covered with masses of soft, yellow cankers closely adhering to the mucous membranes (fig. 19). These yellow, diphtheritic ulcers of fowl pox must be differentiated from the small, deep-seated, irregular, diphtheritic ulcers or cankers often seen in the mouths of turkeys and not associated with typical head lesions. These cankers are common in turkeys that have been vaccinated against fowl pox or that have recovered from an outbreak. Their cause is not known.

There are no internal lesions that are characteristic of the disease.

Course and Mortality.—There is a marked difference in the severity of cases of fowl pox in turkeys and, consequently, in the course of the disease. Whereas mild cases may clear up in two or three weeks, severe outbreaks often last for six, seven, or even eight weeks. The canker or mouth types take longer to clear up. In such cases, starvation is the cause of death. Blindness often occurs, after the closing of the eyes by severe infection of the eyelids. When the eye is involved, a yellowish cankerlike lesion develops on the mucous membrane of the lid.

The flock mortality is usually low, most of the losses being caused by blindness or starvation. Setback in development and loss in weight are of greater financial importance in the growing flock than the loss in deaths. As outbreaks commonly occur a few days or weeks before market time, it is often necessary to postpone killing the birds for several weeks. If the flock escapes an outbreak before market time, the disease sometimes appears in the breeding flock and causes severe losses through lowered egg production and poor fertility.

Prevention.—Vaccination with live-virus vaccine, together with the usual sanitary program, is the recommended method of preventing fowl pox in turkeys. The problem differs from that in chickens because in the latter the effect of the disease and vaccination on egg production must be considered in the preventive program, while in the former a

meat-producing bird only is involved. Furthermore, according to data collected by the writer on several thousand turkeys over a six-year period, healthy turkeys respond to vaccination, even when virus of chicken origin is used, with little or no systemic disturbance, such as sometimes follows vaccination of chickens. Consequently there is no need for using a less virulent strain of virus—for example, one of pigeon origin.

Vaccine of chicken-pox origin, prepared after the methods of Beach, Johnson, and others, produces a solid immunity in turkeys for at least one year. All the common methods of inoculation of the vaccine have been found equally efficient when properly followed.

Need for Vaccination.—Fowl pox is so widespread in California that yearly vaccination of all turkey flocks is a good insurance policy. The one exception to this general recommendation is the flock well isolated from all chicken flocks and located in a community where the disease does not exist. Since the vaccine used for immunizing a flock contains live virus, capable of spreading the disease, it cannot safely be introduced into a flock or a community where fowl pox is unknown.

The disease is probably carried to new areas by mosquitoes, birds, visitors, animals, secondhand feed sacks, and the introduction of new stock. Turkey growers who do not vaccinate should keep a constant watch for the first appearance of lesions and should immediately obtain advice on the best plan of control.

Age for Vaccination.—There are considerable data to indicate that healthy turkeys can be vaccinated at any age. Dunn and Sherwood[24] have successfully vaccinated day-old turkeys. Many California growers have vaccinated successfully at six or eight weeks of age; the majority, however, at ten to twelve weeks. Extreme care must be taken when vaccinating very young poults, to prevent the vaccine from getting on parts of the body other than the area to be treated. Sometimes a careless operator, after spilling vaccine, holds the poult's head with his contaminated hand. The young, tender skin is so susceptible that a severe case of generalized pox may follow.

As it requires from four to eight weeks for the vaccination lesion (take) to disappear completely, turkeys should be vaccinated at least eight weeks before market time. July, August, and early September are desirable months for vaccination in most sections of California. Ample time is then allowed for the flock to develop immunity before the period of the greatest danger of infection, namely, October to June, and for the vaccination area to heal before any birds are killed for market.

[24] Dunn, R. C., and R. M. Sherwood. Immunization of day-old chicks and poults against fowl pox. Poultry Sci. 12:323–24. 1933.

Breeders kept for more than one year should be vaccinated each year because a small percentage of them will have lost their immunity after one year. This recommendation is based on immunity tests made each year for a period of five years on the breeding flock kept at the experimental plant at Davis.

Purchase and Care of Vaccine.—Vaccine, not being a stable product, should be purchased only from reliable sources. If it cannot be obtained from a local veterinarian, the county farm advisor's office will probably have a list of available sources. It must be kept and used strictly according to directions given by the manufacturer and must be stored in the refrigerator when not in use. One-half day's supply, only, of the concentrated product should be diluted at one time; and this should be protected against undue heat and exposure to the sun's rays. In hot weather it is advisable to dilute only enough of the concentrate for an hour's use unless the diluted portion can be kept packed in ice. All diluted vaccine not used during the time for which it was prepared should be discarded.

Disinfectants should never be added to the vaccine, nor should the container for vaccine be rinsed in a disinfectant unless it is later rinsed well with water and dried before use. Instruments and brushes for applying the vaccine should not be kept in disinfectants unless they can be thoroughly rinsed before being used. When the stick method is employed, the knife point should be wrapped with clean, fresh tape daily.

Technic of Vaccination.—There are two general methods of applying the vaccine: the feather-follicle and stick, or puncture, methods. The feather-follicle method consists in pulling a few feathers and inserting the vaccine, with the aid of a brush, into the feather follicle. The stick method consists in pricking the skin with a sharp instrument previously dipped in vaccine. A modification of the puncture method is the scarification method, in which the skin is scarified, or scratched, with a roughened metal surface that also serves to carry the vaccine into the injury.

Some modification of the stick method is most common today, and it has many advantages over the feather-follicle method, among them being economy in the use of vaccine, greater speed in the application of vaccine, and better control of the amount of vaccine inserted and of the number of lesions or takes produced.

At this station, careful comparisons have been made on the immunity developed by applying the vaccine to the skin of the leg, the skin of the wing web, the caruncles, and the skin of the breast. There were no marked differences in immunization in any case.

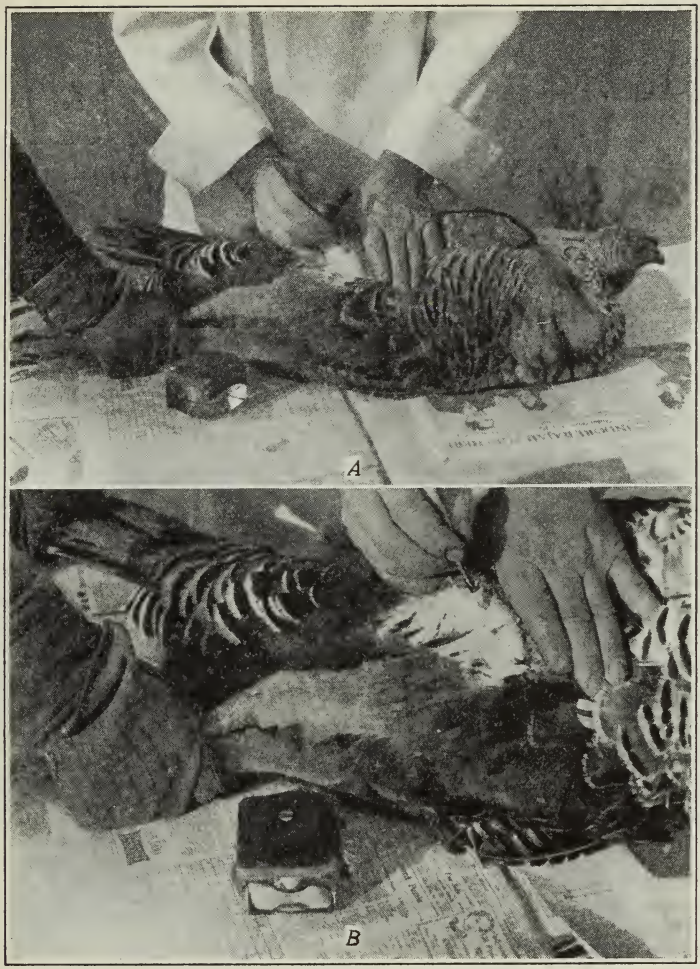

Fig. 21.—*A*, Restraint of turkey for vaccinating on upper thigh. Note that the table is covered with newspapers. This aids in preventing undue spread of vaccine. *B*, A close-up, taken to show the suggested location. The long tuft of feathers that normally cover this naked area is being held back by the vaccinator's left hand. The heavy glass inkwell is a convenient holder for the vaccine. To prevent excessive dust contamination, it is covered with a piece of rubber in which is cut a small opening.

The skin of the upper thigh has certain advantages over other sites for routine vaccination (fig. 21) : these are easy accessibility to the operator, absence of feathers, and inaccessibility to the vaccinated birds or their penmates. The last point is important from the standpoint of the spread of fowl pox by fighting before immunity has been established.

It is inadvisable to vaccinate on the wing web during the late fall rainy season, for dampness and moisture foster the spread of lesions over as much as half of the wing-web area (fig. 22). Turkeys pick at

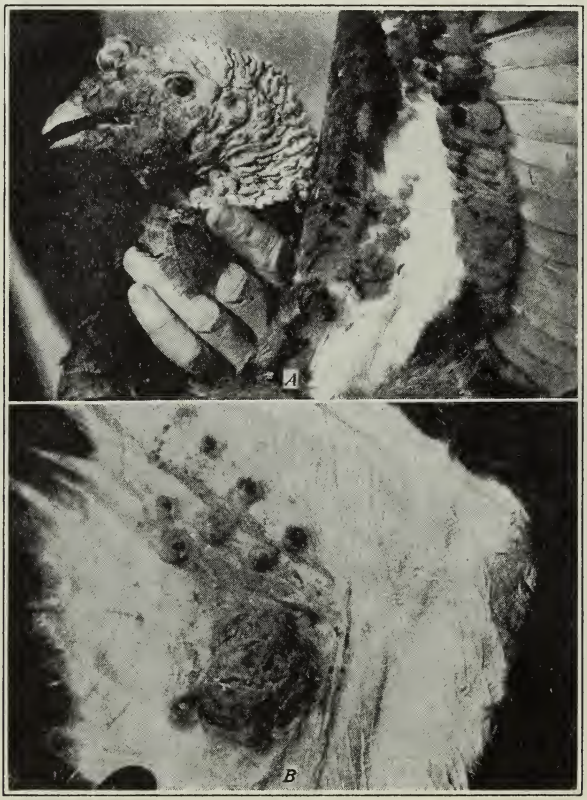

Fig. 22.—*A*, Wing-web vaccination. This picture, taken about six weeks after vaccinating in the wing web by a single stab of the inoculating knife, shows how the disease spread from this single inoculation to other areas on the wing and head. The bird died within a few days after the picture was taken. *B*, Close-up of *A* at a somewhat earlier stage.

the vaccinated area of the wing web, and probably cause the spread of lesions to the head, which seems at times to follow wing-web vaccination.

The large caruncles at the base of the unfeathered part of the head furnish a convenient area for vaccinating and for observing later the results of vaccination (fig. 23, *A*). On the other hand, this area has two disadvantages in its proximity to the most susceptible parts of the body and in its open exposure to other turkeys. No serious spread from this

site of vaccination has, however, been observed; and the immunity conferred has been as good as in the case of any other vaccination area.

A site for vaccination which is adaptable to certain conditions is the small web of skin between the first digit of the wing and the metacarpus (fig. 23, *B*). This area is suggested when, for some reason, vaccination has been delayed until three or four weeks before market time. A small

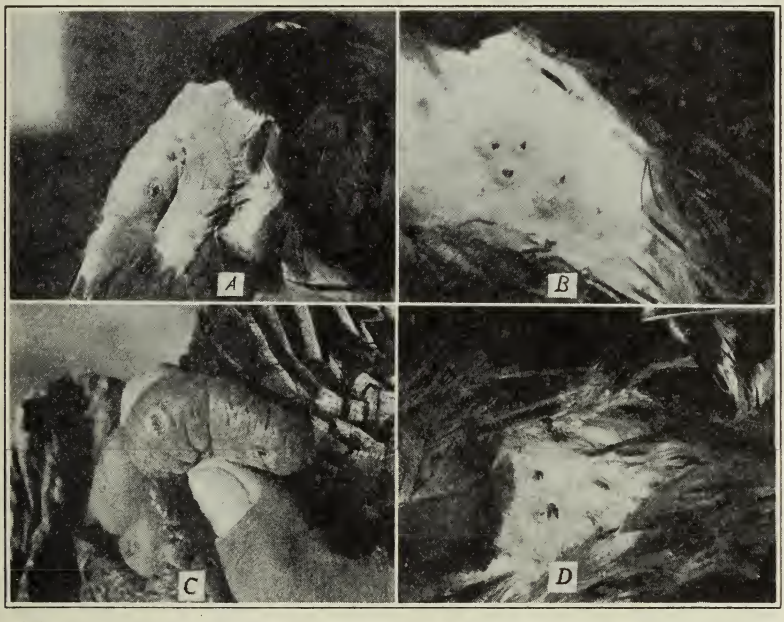

Fig. 23.—Types of "takes" obtained after vaccination in the different areas: *A*, "first finger" of the wing with two inoculation takes one week after inoculation by the puncture method; a slight swelling of this appendage is usually noted; *B*, results of feather-follicle vaccination; four follicles one week after vaccination show typical swelling and scab formation; *C*, caruncle showing two takes by the puncture method one week after inoculation; *D*, results of puncture inoculation on the skin of the leg.

unhealed vaccination scar on this spot will not impair the value of the bird when it is graded for market. Being less convenient than the leg, however, this location is not recommended for routine purposes.

There are many methods of applying the vaccine by the stick method, but the principle is the same for all of them. Figure 24 shows two suitable instruments, together with a good brush for use in the feather-follicle method. One instrument is made from a Bard-Parker knife (No. 3 handle with No. 11 blade) by wrapping the end first with a small piece of cotton and then with a strip of adhesive tape so that about $\frac{1}{16}$ inch of the point is exposed. This allows point enough for pricking the skin

and for making a small incision. The cotton and adhesive tape serve as a reservoir for vaccine and prevent the operator from inserting the knife too far through the skin. The second instrument is one made by inserting two phonograph needles in the end of a suitable holder and wrapping and padding them with cotton and thread. A third type of instrument, not shown in the illustration, consists of a small darning needle with the eye end ground off to leave two sharp prongs with an

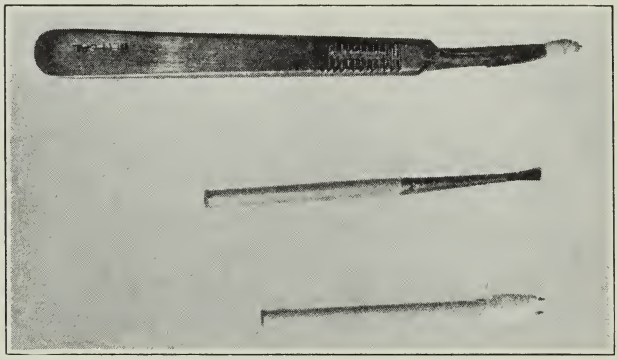

Fig. 24.—Types of instruments in common use for vaccinating against fowl pox.

opening between them for holding a small drop of vaccine. Such a modified needle can be inserted in a suitable handle and has the advantage of inoculating consistent doses of the vaccine. Manufacturers often furnish modifications of these instruments with their vaccine.

The method used in handling the turkeys will, in a large measure, determine the number that can be vaccinated in a day. There are many ways of organizing the work, but for large flocks two adjoining corrals with a chute between them for confining a few birds in close quarters are essential (fig. 26). The system must be turkey-tight so that unvaccinated birds will not escape into the vaccinated group. A table at a location convenient to the catching chute provides a good surface for holding the bird, as well as the vaccinator's apparatus (fig. 26, *B*). A helper may hold the turkey and expose the area to be vaccinated, so that the operator need not touch the bird. *Helpers should avoid handling the vaccine, and every precaution should be taken to prevent its being spilled.* One good plan is to keep the vaccine container and the instruments on a newspaper spread over the table (fig. 21). This paper can be rolled and burned at the end of the vaccinating period.

If the upper-thigh location is used for the site of vaccination, the helper holds the feet of the bird with his right hand as shown in figure

21. The vaccinator pulls back the feathers lying along the thigh to expose the skin, inserts the instrument (which has been dipped in the vaccine) into the skin, and makes a very slight incision. If the single-point knife is used, this procedure is repeated once or twice, at places ½ to 1 inch apart, without renewing the vaccine. Two or three punctures of the skin are ample. The helper then places the bird in the vaccinated quarters. The helper can also expose the vaccination area for the vaccinator, but he should avoid getting his hands into the vaccine in allowing the tuft of feathers to fall back into place. After each inoculation, the vaccinator mixes the vaccine thoroughly, using his operating instrument, which at the same time picks up a new supply of vaccine for the next inoculation. *The most important points to be kept in mind during vaccination are to use fresh, potent vaccine and to be certain that the vaccine is inserted into an injured skin.* Accuracy should not be sacrificed for speed.

The general location mentioned above can be used if the feather-follicle method of inoculation is preferred. Not over four or five feathers should be pulled, and care should be taken to be sure that vaccine has been brushed into the follicle. The small baby-feather follicles are as sensitive to the vaccine as the large pin-feather types.

All unused vaccine, together with the containers, should be burned or placed in disinfectant for several hours to prevent the spread of virus. All cotton, tape, and thread wraps and papers should be removed and burned. Instruments should be put in some good disinfectant for several hours and then thoroughly rinsed with boiled water, or they may be boiled for 10 minutes.

Post-Vaccination Care of the Flock.—If the flock is in good healthy condition, it need receive no special care after vaccination. Sometime between the eighth and the twelfth day, at least 25 per cent of the flock should be examined to determine whether the vaccination has been successful. If all of the birds in such a sample have one or more vaccination takes (fig. 23), the flock can be considered properly immunized. If not all have reacted, the entire flock should be handled, and the nonimmunized birds should be revaccinated with a fresh lot of vaccine. As the birds cannot be considered immune until about one month after vaccination, precautions should be taken to prevent introduction of the disease until after that period. A few vaccinated birds may develop lesions on the head, but these usually clear up within a short time without any severe symptoms. It is well, however, to isolate such birds from the remainder of the flock to prevent spread by fighting before immunity is established.

Reasons for Failure of Vaccination.—Each year, many letters ask why flocks that have been vaccinated have shown no takes when handled in 8 or 10 days after vaccination. The chief reasons for such failures are listed below:

1. Faulty care of vaccine after it leaves the manufacturer:
   a) Undue exposure to heat in shipment
   b) Improper care by the dispenser (feed store, druggist, veterinarian) or by the purchaser
2. Use of old vaccine kept beyond the manufacturer's expiration date
3. Improper use of diluted vaccine:
   a) Undue exposure to heat or sunlight
   b) Failure to make up fresh supplies at short intervals
   c) Failure to keep the vaccine well mixed
   d) Attempts to economize by greater dilution than recommended by the manufacturer
4. Inefficient inoculation:
   a) Failure to dip the instrument into the vaccine after each inoculation
   b) Failure to separate the feathers properly to expose the skin, with resultant loss of a large part of the vaccine as the instrument passes through the feathers
   c) Failure to make an incision in the skin
5. Sacrifice of accuracy for speed
6. Previous immunity because of former outbreak or because of natural resistance

Control of an Outbreak.—If fowl pox appears in a flock, the following procedure is recommended:

1. Isolate all birds showing lesions.
2. Vaccinate as soon as possible all birds not showing lesions.
3. Place infected birds in warm, dry quarters if available.
4. Separate the males or keep careful watch over them to prevent fighting.
5. Treat infected birds individually by removing the scabs and touching the wounds with iodine, if time permits and the expense warrants it. An iodine ointment such as Iodex applied liberally over the infected area will aid in reducing the spread of the disease and will shorten the period of convalescence. Saturated boric acid solution is recommended for washing the eyes.
6. Individual feeding of valuable birds with the aid of a funnel and rubber tubing inserted into the crop may be advisable in severe cases.

Drugs for internal treatment are not recommended. Since loss of flesh and slowed-down development are the chief causes of economic loss in most outbreaks, careful management and attention to the feeding program during and after an outbreak are essential to a speedy return to normal. The course of the disease can be shortened by the use of shelter for roosting and by general protection from damp weather.

FOWL TYPHOID

Fowl typhoid is a septicemic infection caused by *Salmonella gallinarum*. Cultures of this organism isolated from outbreaks among turkeys have resembled bacteriologically those isolated from chickens. Flocks grown in confinement have appeared more susceptible than those raised on open range; and contact with chickens, or yards used by chickens, apparently has been an important factor in the spread of fowl typhoid to turkeys.

Symptoms, Course, and Mortality.—Increased thirst, loss of appetite, listlessness, a tendency to separate themselves from the well birds, and a greenish to greenish-yellow diarrhea characterize the disease in the field. The sick turkeys sit around with drooping tails, sagging wings, and heads hung low or carried back over the body and resting on or under the wing. As indicated by the increased thirst, the body temperature rises several degrees, to as high as 112° Fahrenheit until just before death, when it may drop to as low as low as 103°.[25]

Often birds die without having shown any previous symptoms, but usually they linger for a day or two after symptoms appear. Several outbreaks may occur in a flock in a single season, or the original one may be acute and last for only a few days. Intermittent outbreaks are more liable to occur if the birds are left on the originally infected premises or have constant contact with carrier chickens or turkeys. The initial outbreak usually causes the heaviest mortality, which is followed by intermittent recurrence of symptoms in a few birds, with a low mortality at each subsequent flare-up of the disease. Although the average mortality in four outbreaks studied was 26.5 per cent, heavier losses have often been reported. One flock owner lost 169 out of 175 turkeys during the fall and winter in intermittent outbreaks.

Autopsy Findings.—The lesions resemble those observed in chickens. Because of the short duration of the disease, the birds nearly always die in good flesh. The muscles of the breast have a tendency to be congested and often appear as if partially cooked. The heart is usually swollen and contains small grayish necrotic areas or pin-point hemorrhages (petechiae); in a few cases both have been observed. The liver is friable and is consistently enlarged to two or three times its normal size; it is bronze to mahogany-colored or covered with a mixture of bronze and mahogany-colored streaks. Pin-point areas of necrosis have been noted though not consistently; and, on cutting, the blood flows readily. The

[25] The average temperature of 21 normal young mature turkeys from three different ranches was found to be 105.9° F, with a range of 105.2° to 106.8°.

spleen is always enlarged to two or three times its normal size, is friable, and appears mottled. In most birds the lungs present a parboiled appearance; and often they are more firm than normal, because of minute caseated abscesses. The kidneys are usually enlarged and may show some petechiae.

The crop, as a rule, contains food, which indicates paralysis of the digestive tract, since birds seldom eat after symptoms appear. The mucous membrane of the proventriculus sloughs readily. The gizzard usually contains food, and the lining is easily removed. With a few exceptions the intestine appears anemic when viewed from the exterior, and ulceration of the mucous membrane may be plainly visible through the serous membrane. This ulceration is uncommon but when present is most severe in the duodenum; a few ulcers from 0.5 to 4.0 mm in diameter have been observed throughout the intestine, extending to the ceca.

The enlarged mahogany- or bronze-streaked liver, the enlarged spleen, the areas of necrosis in the heart, and the grayish lungs appear to be pathognomonic. Hemorrhagic enteritis, especially of the duodenum, and marked ulceration of the intestine, although uncommon in chickens, are more or less consistent lesions in turkeys. *Salmonella gallinarum,* the causative organism, can readily be isolated from all organs. In birds that have been dead for some time, pure cultures are more easily isolated from the bone marrow than from the liver, spleen, and heart blood.

Prevention, Control, and Treatment.—Since chickens are apparently the most common carriers of the disease to turkeys, the two species should never be allowed to mingle. It is equally important to keep turkeys from yards or ranges that have recently been used for chickens.

There is also evidence[26] that turkeys may become carriers and transmit the disease to others and to the young through the egg (fig. 25). Since the disease is not common, however, in very young poults, even in areas where fowl typhoid is prevalent among adult birds, this method of transmission is apparently infrequent. One should, however, eliminate from the breeding flock, as far as possible, birds that have suffered from the disease. If the breeders are to be selected from a flock that has survived an outbreak, agglutination testing (blood testing) is recommended.

Further preventive measures are those applicable to all diseases as described on pages 1–25.

Control depends upon getting rid of the infection in the flock. The

[26] Hinshaw, W. R., and T. J. Taylor. A chronic carrier of fowl typhoid of turkeys. Jour. Amer. Vet. Med. Assoc. 35(n.s.):922–26. 1933.

removal of all sick birds and the transfer of the well birds to a new range that has not been used for either chickens or turkeys is recommended. One method for separating sick birds from well ones in an acute outbreak is to take the temperatures of all birds in the flock and eliminate those showing temperatures above 108° F. Another means of eliminating carriers, which has proved practicable in intermittent losses, is to

Fig. 25.—Ovary from turkey hen, showing diseased ova caused by fowl typhoid. There were no normal ova.

bleed the survivors and have the blood tested by means of the tube agglutination test. A diagnostic laboratory should be consulted before testing the flock.

Just before being moved, the birds should be given a laxative. A good laxative is a mash containing 40 per cent of dried skim milk fed as the morning feed for two days. Epsom salts, if used, should not be given in doses exceeding 1 pound per 1,000 pounds of turkeys. After the birds are moved, the feeding of wheat bran moistened with 2 quarts of mineral oil to each 100 pounds of bran each morning for a week has proved beneficial.

As the greatest source of the spread of the disease is the droppings, the roost should be screened so as to prevent the birds from having access to them. Sick birds should be taken out of the flock as soon as noted; frequent changes of the watering and feeding areas should be

made; and whenever many new cases appear, the flock should be moved again to new quarters.

Next to the droppings, the greatest sources of infection are the food and water containers. They should therefore be cleaned and disinfected daily or even oftener. In the absence of running water, fresh, clean water should be given several times daily. Any antiseptic used should be one that will not make the water distasteful. Antiseptics that prevent the birds from drinking a normal amount of water do more harm than good. Chlorinated lime (containing 24 to 30 per cent of available chlorine) at the rate of 1 tablespoon per gallon or potassium permanganate at the rate of ½ teaspoon per gallon of water is a safe antiseptic (see p. 17, 19–20).

No satisfactory medicinal treatment has been found. Thus far experimental work has not demonstrated that vaccination with fowl-typhoid bacterins is effective for preventing or controlling the disease.

PARATYPHOID INFECTION

Diseases caused in both poults and adult turkeys by members of the *Salmonella* group other than *S. pullorum* and *S. gallinarum* are being reported with increasing frequency in the literature. Rettger, Plastridge, and Cameron[27] in 1933 described an infection caused in young poults by *S. aertrycke* from two New England turkey farms. In 1936, Lee, Holm, and Murray[28] reported on eleven acute outbreaks, all occurring in young poults from midwestern farms; and in 1937 Cherrington, Gildow, and Moore[29] reported outbreaks from Idaho. More recently Edwards[30] reported the identification of another member of this genus, *S. senftenberg*. In California organisms similar to *S. aertrycke* are isolated commonly from poults suffering from acute diseases, less often from adult turkeys.

Symptoms.—In young poults, the affected individuals often appear chilled and remain close to the hover. Diarrhea is not a constant symptom; often poults normal in the evening may be found dead in the morning. Where death is delayed for several days, weakness, unthriftiness, sagging wings, and a thin, watery diarrhea are characteristic symptoms.

[27] Rettger, L. F., W. N. Plastridge, and Ruth Cameron. Endemic paratyphoid infection in turkeys. Jour. Infect. Dis. 53:273–79. 1933.

[28] Lee, C. D., Glen Holm, and Charles Murray. Paratyphoid infection in turkeys. Jour. Amer. Vet. Med. Assoc. 42(n.s.):65–76. 1936.

[29] Cherrington, V. A., E. M. Gildow, and Pren Moore. Paratyphoid in turkeys. Poultry Sci. 16:226–31. 1937.

[30] Edwards, Philip R. The occurrence of Salmonella Senftenberg type, in a disease of turkeys. Jour Bact. 33(2):193–95. 1937.

In older turkeys, loss of appetite, unthriftiness, loss of flesh, and a general unkempt appearance have been the symptoms most commonly observed. Diarrhea may or may not be in evidence. Death usually follows after several days of sickness.

Autopsy Findings.—Inflammation of duodenum, congestion of the liver, kidney, gall bladder, and heart muscle are the most constant postmortem findings. The pericardial sac is often filled with a serous straw-colored fluid. Another common finding is a cecal plug similar to that sometimes seen in pullorum disease and in coccidiosis of chicks.

In adult turkeys, a marked inflammation of the intestine with occasional necrotic ulcers is seen. The liver and spleen in these cases is usually swollen and congested. Diagnosis depends on isolating and identifying the causative organism.

Transmission.—Evidence is being accumulated that paratyphoid infection in turkeys may be transmitted through the egg in much the same manner as pullorum disease. Lee, Holm, and Murray, according to the paper previously cited, were successful in isolating *Salmonella aertrycke* from the ovaries of turkey hens that survived artificial infection. Poults hatched from eggs laid by these same hens developed paratyphoid infection, but the causative organism could not be isolated from the limited number of eggs laid by the carriers. Other evidence on the possible transmission through the egg has been given by Cherrington, Gildow, and Moore, in the paper cited above. At this station, *S. aertrycke* has been isolated from the oviduct of one turkey hen from a flock in which paratyphoid infection was diagnosed in poults. As incubators have been shown by Schalm[31] to be a means of spreading paratyphoid infection in chicks, they are, in all probability, also an important means of transmission to turkeys.

Prevention and Control.—Prevention consists in obtaining stock from sources known to be free of infection and in following the general precautions outlined under "Pullorum Disease," the following section. The agglutination test may prove a valuable means of eliminating carriers from infected flocks. One must bear in mind, however, that an antigen prepared from the causative organism is necessary for detecting carriers. The test used for pullorum-disease carriers may eliminate a few of the related paratyphoid carriers, but it should not be relied upon as a preventive measure.

[31] Schalm, O. W. Study of a paratyphoid infection in chicks. Jour. Infect. Dis. 61:208–16. 1937.

PULLORUM DISEASE

(Bacillary white diarrhea, B.W.D.)

Pullorum disease is primarily a disease of chicks, but since the advent of the commercial hatching of turkey eggs, it has been increasing in importance as a cause of mortality in poults. The disease is caused by *Salmonella pullorum.*

Pullorum disease in turkeys was first described by Hewitt[32] in Minnesota in 1928. Since then it has been reported from many states in this country, from England, and from Holland. Comprehensive reviews of these reports are given by Brunett, Tittsler, and Johnson and Anderson.[33] The disease has been diagnosed frequently in California, and has been increasing in importance yearly.

Symptoms.—The symptoms in poults are identical with those described for chicks. The disease is usually very acute, and many poults die without showing any noticeable symptoms. Poults that show symptoms seem cold and sit around the hot part of the hover space. Their wings sag, their heads hang, and their feathers appear unkempt. The skin over the feet and legs usually appears dry and somewhat wrinkled. Diarrhea may or may not be in evidence; but in most of the cases that are prolonged for 2 or 3 days, diarrhea is indicated by the pasting of the down around the vent. Labored breathing, due to pneumonia, is commonly observed.

Course and Mortality.—Most of the losses occur during the first three weeks after hatching, although they start any time from the third to the seventh day. The mortality varies considerably. In 32 outbreaks involving 19,647 poults, the average mortality, as reported by the owners in reply to questionnaires or in personal interviews, was 34.5 per cent. The maximum mortality reported was 100 per cent in a brood of 25 poults; the minimum, 12 per cent in a brood of 1,250.

Autopsy Findings.—The post-mortem findings are not typical of pullorum disease alone, and only by bacteriological examination of tissues can a positive diagnosis be made. The liver is commonly congested and may be of a yellow or ocher color with streaks of red. Pneumonia, associated with minute caseous abscesses of the lungs, is a frequent observation. The intestines lack tone and contain an excessive mucus discharge.

[32] Hewitt, E. A. Bacillary white diarrhea in baby turkeys. Cornell Vet. **18**:272–76. 1928.

[33] Brunett, E. L. Pullorum disease in the mature turkey. Poultry Sci. **9**:356–60. 1930. Tittsler, R. P. Pullorum disease in poults. Poultry Sci. **11**:78–80. 1932. Johnson, E. P., and G. W. Anderson. Pullorum disease in turkeys. Jour. Infect. Diseases **58**:337–48. 1936.

The lesions in the adult carriers examined at this station have been confined principally to the reproductive tract. In the only male carrier studied, the lesions were obscured by a foreign body that had punctured the gizzard, and caused a marked peritonitis. The resulting adhesions had involved the right testicle, the lungs, and the air sacs. *Salmonella pullorum* was isolated from the pericardial fluid, the peritoneal cavity, the air sacs, and the right testicle. In the females the lesions were usually located in nonfunctioning ovaries or consisted of caseated yolk masses in the oviduct or abdominal cavity. One female carrier had a normal ovary, just starting to function. Its oviduct contained about a tablespoon of a yellow, soft, semiliquid exudate, from which a pure culture of the causative organism was isolated. *S. pullorum* was isolated from the bursa of Fabricius in one instance.

Methods of Transmission.—A total of 945 eggs from turkeys that had once reacted to the agglutination test have been examined bacteriologically at this station. From these, 5 cultures of *Salmonella pullorum* were isolated. The significant fact that *S. pullorum* has been isolated from the ovaries of adult turkey hens shows the possibility of transmission through the egg even though the percentage of positive findings in these studies is small. In no instance in California has the disease been traced directly to transmission through eggs laid by adult turkey hens in commercial flocks.

For the past several years, with the coöperation of the California State Department of Agriculture, records have been obtained from as many as possible of the outbreaks occurring in poults in California flocks. These outbreaks have all been associated with chicks, either in the hatchery or in the brooder. Reports, already mentioned, by Brunett, Tittsler, and others, substantiate the findings made at this station—namely, that the chicken carrier and the incubator are the two principal means of transmitting pullorum disease to turkeys. The fact, however, that the turkey hen may also be a carrier is a warning that the disease may become established in turkey flocks.

Prevention.—According to the data presented above, the best ways to prevent pullorum disease from spreading to turkey flocks are to prevent turkey eggs from being hatched in the same incubator as chicken eggs, to avoid brooding poults and chicks together or in the same brooder house, and to segregate turkey breeding flocks from chickens. If commercial hatcheries will coöperate with turkey growers by hatching turkey eggs in separate incubators from chicken eggs and by handling newly hatched poults in a separate room from the chicks, much will be accomplished towards prevention.

As the disease is not widespread at present, a general testing program for turkey flocks is not necessary. *Owners who have had losses from the disease should, however, either sell the entire flock for market purposes or have their flocks tested for carriers.* In most instances, selling the

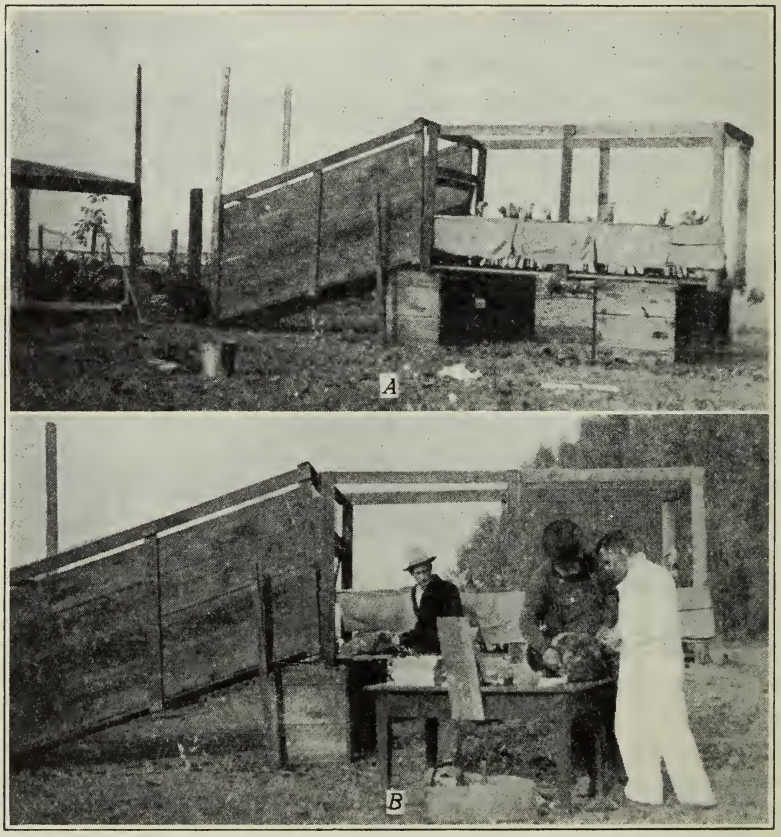

Fig. 26.—*A*, A type of catching chute for handling large numbers of turkeys for vaccination, blood collecting, or other purposes. *B*, the same setup showing how a bird can be removed from the side, by reaching through the burlap "fence," without disturbing the other turkeys. A convenient type of table for restraining the birds and holding the equipment is also shown.

flock and buying replacements from reliable sources in the form of eggs or day-old poults will prove the most economical procedure. The brooders, equipment, and yards should be thoroughly cleaned and disinfected before being used for the new poults.

If the infected flock is to be kept for breeding purposes, it should be tested early in the fall so that there will be ample time for several retests to insure removal of all the reactors. Two methods of making the

agglutination test for carriers are in common use. The limited number of tests made with the so-called field or whole-blood method have indicated that it is not as reliable as the test-tube or laboratory method for detecting carriers of pullorum disease in turkeys. Until more data are

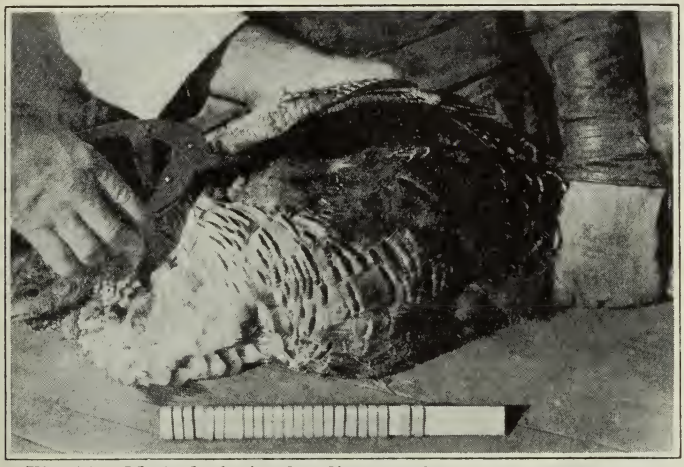

Fig. 27.—Method of wing-banding a turkey with sheep ear tags described in the text. See figure 28.

Fig. 28.—Close-up of the wing with a tag properly inserted.

collected on this method, blood samples had best be sent to a reliable laboratory. Information regarding laboratories can be secured from veterinarians or from the local farm advisor. If the information is not available locally, a list of laboratories making tests will be sent on appli-

cation to the Division of Veterinary Science, University Farm, Davis, California.

Bleeding the Flock for the Agglutination Test.—Since the breeding flock can usually be selected early in the fall and separated from the birds to be marketed, the turkey grower should do this before bleeding for the first test. At least 25 per cent more turkeys than are needed for the breeding flock should be separated to allow for losses caused by re-

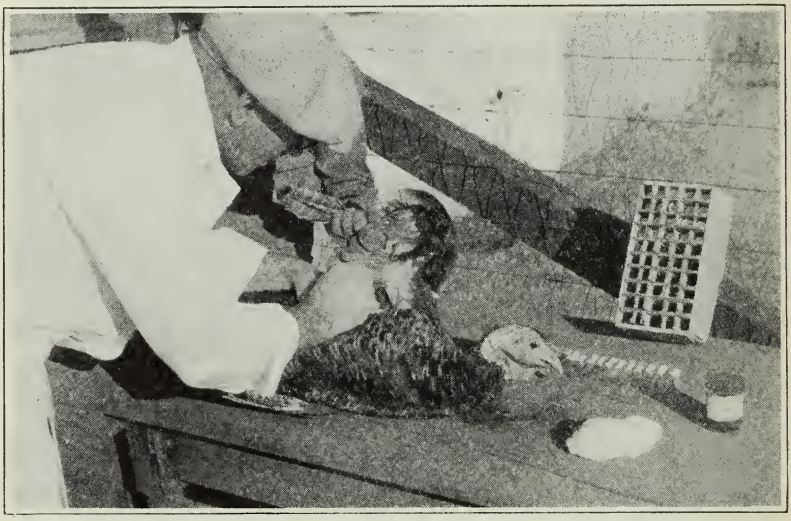

Fig. 29.—A suggested setup for collecting blood samples from turkeys.

moval of the reactors to the test. Males as well as females should be tested; and any chickens or other fowls kept in the vicinity should also be tested.

Much the same arrangement as was suggested for handling birds for fowl-pox vaccination is recommended for corralling the birds to be bled. A convenient setup is shown in figure 26. A procedure for collecting follows:

1. Catch the bird, and identify it with either a wing band or a leg band. The type of wing band shown in figures 27, 28, and 31, *D, F,* is a very good one for marking adult turkeys. It is an aluminum ear tag, commonly used for marking sheep, and is put on with special pliers (fig. 31, *G*) which clinch the band so that it is not readily lost. This type of a band is recommended as a substitute for a leg band. A leg band is often torn off, and may be the cause of a leg injury if the turkey gets it caught in a fence or similar obstacle.

Bands should be purchased in consecutive numbers for as many birds as are to be bled. It is a good plan to have the numbers for each succeeding year start with the series following that completed during the previous year. For instance, if 1–1,000

is used one year, 1,001–2,000 can be used the second year. Since breeders are seldom kept longer than two years, the series can start over for the third year. Such a system reduces to a minimum the danger of duplicating numbers.

2. Lay the turkey on the table with the right wing folded under the body and the left wing exposed. With the right hand, the legs of the bird should be held rigid and stretched out from the body. The left hand can then be used to extend the wing and expose the wing veins for the blood collector (fig. 29).

3. Pull out the feathers over the second joint from the body to expose the wing vein (fig. 30). The area may be brushed dry and clean with a piece of cotton, but it is not necessary or advisable to disinfect it before bleeding.

4. Puncture the vein with a quick lengthwise movement of a sharp instrument like the knife illustration in figures 30, *A* and 31, *A*.

5. Collect the blood immediately in the vial (fig. 30, *B*). Fill it at least one-third full. Cork it tightly, and label it with the wing or leg band number (fig. 31, *C*). *Write numbers plainly.*

6. Place the vials in a tilted position to allow the blood to clot on a slant (fig. 31, *B*).

7. If excessive bleeding occurs, place a small piece of absorbent cotton or a tuft of downy feathers over the wound before releasing the bird. Although turkeys bleed more easily than most chickens, they seldom bleed excessively. A few drops of 1 per cent solution of ferric chloride will aid in stopping excessive hemorrhage.

8. Cool the blood in a refrigerator, or pack the samples in ice for shipment to the laboratory. Ship the samples as soon as possible. If samples are to travel for any distance, two drops of a saturated solution of boric acid in sterile physiological saline in each vial will preserve the blood until it arrives. Pack the samples well for shipment, and send them to the laboratory by the quickest route available.

Additional precautions to observe when collecting and shipping blood samples are as follows:

1. Use clean, sterile vials and corks. They may be sterilized by boiling for 10 minutes in clean water and can be dried in a hot oven.

2. Have the skin dry at the time of taking the sample.

3. After each sample is taken, thoroughly wipe the instrument used for piercing the vein.

4. Do not place the blood samples in the sun. They must be kept cool to prevent spoilage.

5. Do not allow water to come into contact with the blood.

6. Avoid the use of disinfectants, other than boric acid, for preserving the blood.

Control and Treatment.—There is no practical method of control or treatment once the disease has become established in a brood. Daily cleaning and the removal of all sick and dead poults several times daily will aid in preventing its spread. Cleaning and disinfecting the water fountains and feed hoppers several times daily and the use of fresh, unadulterated water are also recommended. If antiseptics are used in the drinking water, the precautions and suggestions given on page 15 should be observed. No specific remedy against the disease has been found.

Fig. 30.—*A*, Close-up of the wing with knife placed at the point of incision. *B*, Collecting blood in the vial, after making the incision.

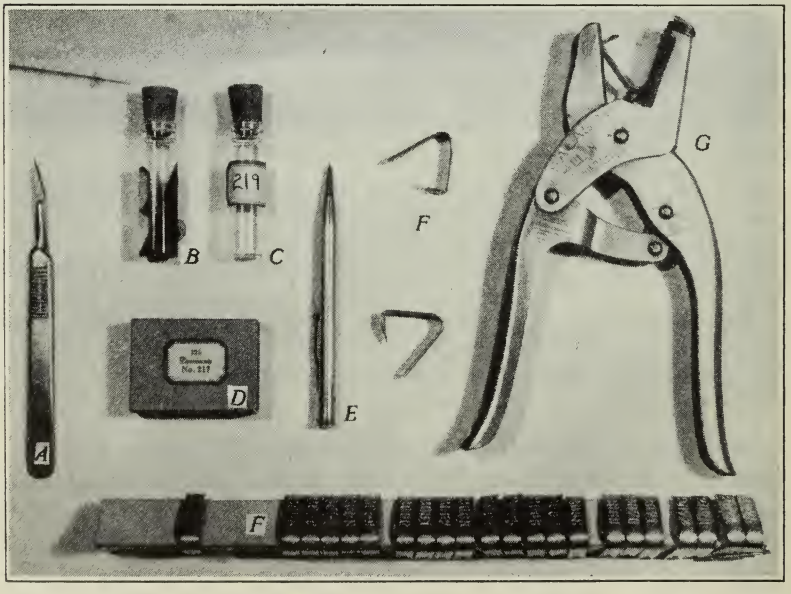

Fig. 31.—The equipment used for collecting blood samples and wing-banding turkeys: *A*, bleeding knife; *B*, *C*, blood vials, *B* with clotted blood on slant, *C*, vial properly labeled with the leg band number; *D*, labels; *E*, pencil for marking labels; *F*, wing bands; *G*, pliers for clinching wing bands.

Every precaution should be taken to prevent contact of an infected brood with other broods that are to be brought into the house after the outbreak is under way. If possible, the brood suffering from the disease should be kept in isolated quarters. Under no condition should equipment used for the infected brood be used for later hatches until it has been thoroughly cleaned and disinfected.

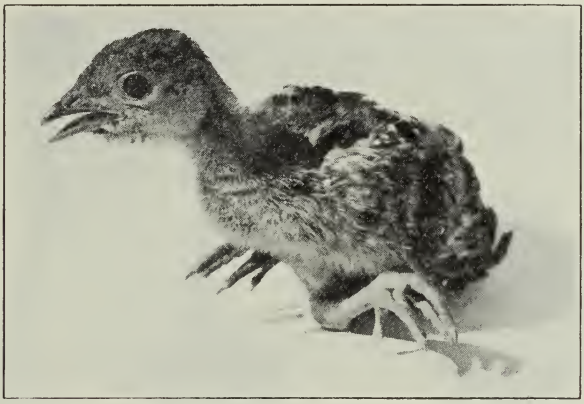

Fig. 32.—Staphylococcal arthritis in young poult. The poult was unable to stand.

When the disease has run its course, the survivors should be toe-marked and, if possible, raised separately from the other lots. None of the survivors should be saved for breeding purposes unless they are tested and found to be nonreactors. The best plan is to market all of them when they are in condition and to select the breeders from the lots that have shown no symptoms. The latter birds should be tested in order to eliminate possible carriers infected by contact with survivors of the outbreak.

STAPHYLOCOCCAL ARTHRITIS

Only recently described by Jungherr,[34] staphylococcal arthritis probably occasions considerable mortality in turkey flocks and may, at times, be mistaken for a nutritional paralysis or be secondary to this condition. It is caused by *Staphylococcus aureus* and occasionally by *S. citreus*. The affected birds become droopy and are usually emaciated before they are observed. The symptoms vary; but, as a rule, the birds rest on their hocks and show swollen hock joints, hot and painful to the touch (fig. 32). The feet may be swollen and typical of the condition commonly called gout (fig. 33).

[34] Jungherr, Erwin. Staphylococcal arthritis in turkeys. Jour. Amer. Vet. Med. Assoc. 35(n.s.):243–49. 1933.

When the affected parts are cut into and examined, a gelatinous to cheeselike flaky deposit will often be found in the subcutaneous tissues. The bursas surrounding the joints are usually swollen and filled with a gelatinous to caseous exudate. No remedy is known. The general recommendations for handling a disease outbreak given on pages 23–25 are advised.

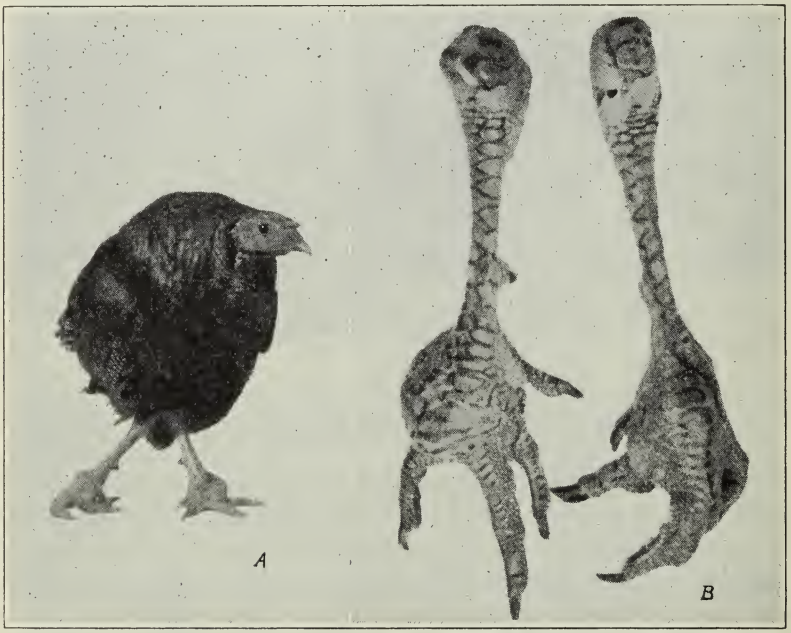

Fig. 33.—*A*, Staphylococcal arthritis in an adult turkey; note swollen joints of the feet. *B*, Close-up of the feet of the turkey shown in *A*.

STREPTOCOCCUS INFECTIONS

Generalized infections in turkeys caused by streptococci are being diagnosed more and more frequently by poultry-disease diagnosticians. Volkmar,[35] reporting several outbreaks of apoplectiform septicemia caused in turkeys by a streptococcus, described the disease as resembling fowl cholera in its manifestations. Although it is not common in California, an occasional outbreak is reported. The losses observed in California have been of a sporadic nature. In these cases the disease is usually very acute, and with few symptoms noted before death.

The principal lesions noted on autopsy are congestion or diffuse hemorrhages in the skin and breast muscles, together with a generalized

[35] Volkmar, F. Apoplectiform septicemia in turkeys. Poultry Sci. 11:297–300. 1932.

congestion of the internal organs. The heart sac is usually filled with a blood-tinged fluid, and a marked hemorrhagic enteritis is common. Often the heart and liver are studded with minute hemorrhagic areas and enlarged.

Isolation of the causative organism is essential in making a diagnosis, although a tentative diagnosis may often be made by microscopic examination of stained smears of the blood and liver tissue. The control measures outlined for fowl cholera (p. 40–42) are suggested.

TUBERCULOSIS

Tuberculosis, a chronic disease affecting turkeys and other fowls, is caused by *Mycobacterium avium* Chester. It is not common in commercial turkey flocks, and all the outbreaks studied at this station have been associated with tuberculous chickens.

Symptoms.—There are no typical symptoms. Lameness and emaciation have occasionally been observed. Many turkeys that are found to show lesions on autopsy maintain their weight for several months before death. Tuberculous turkeys placed in individual cages at this station and observed for periods of one to ten weeks held their initial weight, and a few even gained. Such birds often go through intermittent periods of normality and depression lasting for two or three weeks before death. In the periods of depression, which last for 2 or 3 days, the feathers become ruffled, the appetite diminishes, and diarrhea develops. These periods are followed by a few days of normal appetite and general improvement of health.

Clinical Diagnosis.—Tuberculosis in turkey flocks has, in the experience of the writer, been more often detected by accidental discovery of lesions during an autopsy by the owner, or by the housewife while preparing a bird for roasting, than by symptoms seen in the flock or by the use of the tuberculin test. Hinshaw, Niemann, and Busic[36] found that about 75 per cent efficiency can be expected from the use of the tuberculin test as a means of diagnosing tuberculosis in turkeys. The edge of the wing web (fig. 34) proved to be the best site for inoculation of the tuberculin; but the results, even in this area, were more difficult to interpret than in other animals.

Autopsy Findings.—The gross pathology of tuberculosis in turkeys has not been found markedly different from that of the disease in chickens. The distribution of lesions in the turkeys indicates a tendency for a greater number of organs to become infected than in chickens. Evi-

[36] Hinshaw, W. R., K. W. Niemann, and W. H. Busic. Studies of tuberculosis of turkeys. Jour. Amer. Vet. Med. Assoc. 33 (n.s.): 765–77. 1932.

dently, however, in turkeys as in chickens, the disease is principally abdominal in nature. Figure 35 shows typical examples of the lesions seen in various organs. Seven cases of tuberculosis in turkeys from five California outbreaks have been typed and found to be of avian origin.

A study of the distribution of lesions in turkeys from seven California outbreaks showed that the liver, bone marrow, spleen, intestines, ovaries,

Fig. 34.—Application of tuberculin test. The edge of the wing web proved to be the best site for the injection of tuberculin when testing turkeys for tuberculosis.

mesentery, skin, thymus gland, and lungs were, in the order given, the most common seats of lesions. The ovary and the thymus glands were more often found to be infected than in chickens. Attention is also called to the large percentage of cases of bone-marrow lesions. The number of birds examined for bone-marrow lesions was small as compared to the total, but they were in all stages of the disease. When lesions were found in the bone marrow, they were always found in at least one other organ.

The high percentage of lesions in ovaries suggests the possibility of transmission through the egg. A limited number of eggs from tuberculous turkeys have been examined, however, without discovery of the tuberculosis organisms. The same eggs inoculated and fed to rabbits and turkeys also failed to produce tuberculosis in either species.

Differential Diagnosis.—Some of the conditions noted in turkeys which might be confused with tuberculosis are mycosis, blackhead, and tumors. Mycotic lesions in the liver and kidney, which on first glance are suggestive of tubercles, have been observed. These are not definitely

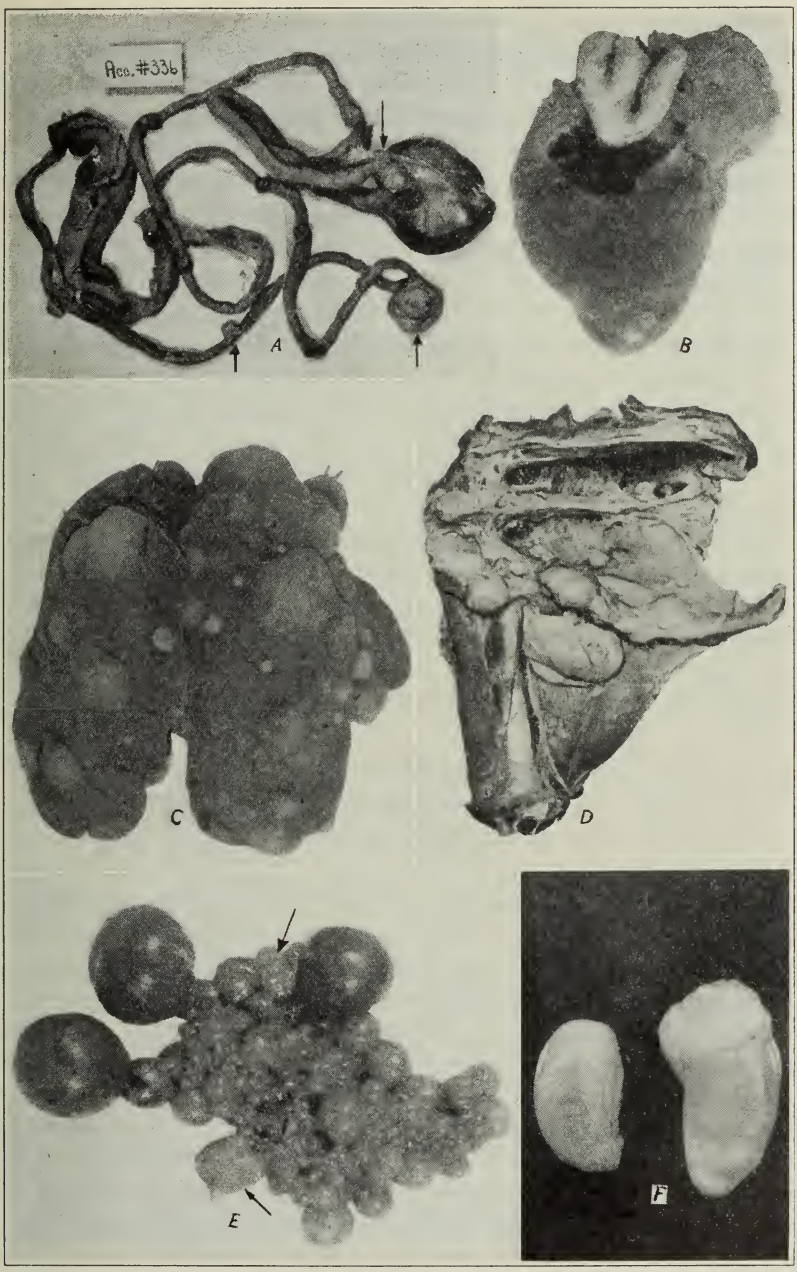

Fig. 35.—Tuberculosis lesions in various organs: *A*, intestines; *B*, heart; *C*, liver; *D*, abdominal and leg muscles; *E*, ovary—arrows point to the diseased ova; *F*, a diseased testicle (right), compared with the normal one from the same turkey.

capsulated and circumscribed, however; and on microscopic examination, mycelia are found, while acid-fast rods cannot be demonstrated.

Blackhead, or infectious enterohepatitis, should not be confused; for the lesions in the liver do not resemble tubercles. Furthermore, the well-known characteristic lesions of the disease in the ceca should help to differentiate it from tuberculosis. On the other hand, tumors of the liver and ovary have been noted that were suggestive of tuberculosis until microscopic examination failed to reveal acid-fast rods.

Prevention, Control, and Treatment.—Complete isolation of turkeys from chickens will do much to prevent tuberculosis. Once the disease is found, it is a good plan to dispose of the entire flock, as well as all chickens on the premises. The best way to dispose of a tuberculous flock of turkeys or chickens is to sell them subject to condemnation. By such a scheme all birds showing lesions of tuberculosis on drawing are destroyed, and the owner is paid for the ones that are in a healthy condition.

Day-old poults, rather than adult stock, should be purchased as replacements. They should be brooded away from the infected area and should not be allowed to range there for at least one year after the diseased birds have been disposed of. A careful grower may sell the entire flock each year and start with day-old stock each spring for several years in order to insure freedom from tuberculosis. No treatment is known.

PROTOZOAN DISEASES

BLACKHEAD

(Infectious enterohepatitis)

Blackhead has probably caused more losses to the turkey industry in this country than any other single disease. First described by Cushman in 1893, it has since led to the abandonment of turkey growing in many sections of midwestern and eastern United States. No turkey disease has been more often described and discussed. The early researches of Salmon, Higgins, Smith, and Graybill paved the way for the later studies by Tyzzer, Rettger, Billings, Van Es and Olney, and others, which have proved that the disease can be prevented by proper attention to sanitary details to be mentioned later.

Cause.—Blackhead is caused by a protozoan (one-celled animal) parasite called *Histomonas meleagridis.* This parasite has an unusual life history, one which for many years baffled some of the best American scientists. It is harbored by the common poultry cecum worm, *Heterakis gallinea,* found in the ceca, or blind pouches, of a large percentage of chickens. This, together with the fact that chickens are not, as a rule,

highly susceptible to the parasite, has frequently been responsible for the transmission of the disease from apparently healthy chickens to turkeys.

The parasites are resistant and capable of living for long periods in the cecum worm and its egg. Van Es and Olney[37] found that the infection remained in vacant yards from the middle of November until the middle of June during each of five years when turkeys were reared in the yards from June to November. For a more detailed discussion of the parasite and a description of the organism, the reader is referred to the works of Tyzzer, Delaplane, and DeVolt and Davis.[38]

Symptoms.—Blackhead, the common name for infectious enterohepatitis, is a misnomer. Sometimes the head does become darkened, but this symptom is not characteristic of blackhead alone. Drowsiness, weakness, drooping wings and tail, a lowered head, ruffled feathers, and a constant sulfur-colored diarrhea are characteristic symptoms. As a rule, adult birds are sick for several days before dying and become very much emaciated. Young poults may have a very acute type of the disease and may die soon after symptoms are noted. Although turkeys of all ages are susceptible, the heaviest losses occur during the first twelve weeks of life. Another peak of mortality is often observed just after the birds are put on the finishing ration to prepare them for market. Sometimes a third peak of losses occurs during the breeding season, probably because of relapses from early infection.

The mortality is high, often approaching 100 per cent of the flock, and averages about 50 per cent unless kept under control. Once the disease attacks a flock, occasional birds are liable to die between the intermittent periods of heavier losses, especially if the flock is not moved frequently to uncontaminated grounds. The period of incubation after contact with infection is 15 to 21 days.

Autopsy Findings.—The liver and the ceca are the principal organs showing marked changes caused by blackhead. The severity of these changes varies with individuals. The cecal lesions are apparently the

[37] Van Es, L., and J. F. Olney. Diseases of poultry—their nature and control. Nebraska Agr. Exp. Sta. Bul. 290:1–110. 30 figs. 1934.

[38] Tyzzer, E. E. The flagellate character and reclassification of the parasite producing blackhead in turkeys—*Histomonas meleagridis* (Smith). Jour. Parasitol. 6:124–31. 1920.

Tyzzer, E. E. Studies of histomoniasis or "blackhead" infection in the chicken and the turkey. Amer. Acad. Arts and Sciences Proc. 69(5):189–264. 1934.

Delaplane, J. P. Etiological studies of blackhead (entero-hepatitis) in turkeys. Rhode Island Agr. Exp. Sta. Bul. 233:1–15. 1 fig. 1932.

DeVolt, H. M., and C. R. Davis. Blackhead (infectious enterohepatitis) in turkeys, with notes on other intestinal protozoa. Maryland Agr. Exp. Sta. Bul. 392:493–567. 1936.

Fig. 36.—Ceca of a turkey affected with blackhead. One cecum is swollen, with discolored diseased areas near the middle and at the tip. The other shows a single lesion near the middle. (From Cir. 294.)

primary ones, and one or both ceca may be affected (fig. 36). The lesions consist of marked inflammatory ulcers, sometimes involving most of the organ. A single ulcer may pierce the serous membrane and form an opening through the entire wall. The mucous lining often becomes necrotic, much thickened, and covered with a characteristic foul-smelling, yellowish-green, semicaseous exudate; or a dry, hard, cheesy core may fill the cecum.

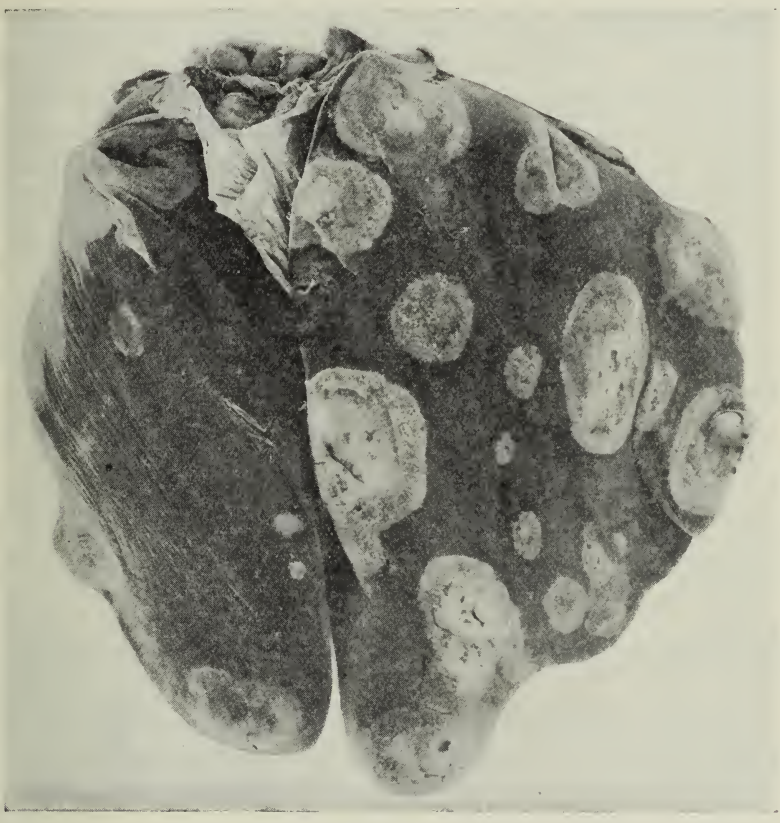

Fig. 37.—Liver of turkey affected with blackhead. (From Cir. 294.)

The affected liver (fig. 37) presents a characteristic appearance, with areas of necrotic and degenerated tissues on the surface. These are more or less circular, have a yellowish to yellowish-green appearance, and, in contrast to tumors and tubercles (tuberculosis), are somewhat depressed below the liver surface. They extend deeply into the tissue and are more or less confluent with the healthy tissue. In older birds the individual

lesions are often merged. Evidence of healing is seen in the large amount of scar tissue in older birds.

Occasionally peritonitis and involvement of the other organs in the vicinity of the liver may be observed.

Treatment.—Many drugs, including ipecac, emetine, catechu, sulfur, atoxyl, arsenous acid, tartar emetic, neoarsphenamine, and tryparsamide, have been tried, but with little success, in controlling blackhead. The only promising one is tryparsamide as suggested by Tyzzer,[39] a drug too expensive except for very valuable flocks.

Prevention.—Blackhead is a filth-borne disease dependent on carriers, including not only chickens and turkeys but probably other birds as well. These carriers eliminate the causative organism in the feces, alone or within the cecum worm and its egg. When the organism is ingested by susceptible stock, the disease breaks out. As there is no practicable method of identifying carriers, all chickens and turkeys must be under suspicion.

The greatest need for prevention is during the most susceptible age, from hatching to twelve weeks. Van Es and Olney, in the bulletin previously cited, suggest the following methods of preventing losses from blackhead:

1. Artificial incubation in order to escape the hazard arising from close association with the parent bird in the same environment.

2. Brooding in an enclosure from which all infection hazards have been previously excluded by attention to such details as hardware-cloth floor covering, and all other measures by which actual contact with soil can be avoided.

3. Maintenance of the poults at least up to twelve weeks old, on clean ground not previously occupied by either turkeys or chickens.

4. Provision of a wide range for the maturing bird—if possible, one not previously occupied by blackhead-infected fowls. If such an environment is not available and the turkeys must be confined in more constantly occupied enclosures, yards should be covered either with coarse gravel or with 1-inch hardware cloth.

5. Maximum protection against the fecal contamination of food and water by the use of feeding and watering equipment specially designed for the purpose (see p. 8–12).

Billings[40] modifies this method of rearing turkeys free from blackhead. His plan is essentially the same as that of Van Es and Olney, being based on prevention by elimination, as far as possible, of the most important source of infection—namely, contamination of food and water with fecal matter from carriers. The principal difference in the two plans is

[39] Tyzzer, E. E. Arsenical compounds in the treatment of blackhead in turkeys. Jour. Exp. Med. 37:851–73. 1923.

[40] Billings, W. A. Talking turkey. Minnesota Agr. Ext. Spec. Bul. 124:1–28. 9 figs. 1928.

in the substitution of a four-yard rearing system by Billings for the fourth step in the Van Es and Olney plan. The four-yard rearing system consists in dividing 1 acre into four yards. These are divided as suggested in figure 38. Three hundred poults can be raised in such a unit. The poults are reared for a month in each of the other yards in succession. They are moved each month until marketed. The acre of ground can be fenced into the ¼-acre sections; or the fence may be a temporary one, set up around a different section each month.

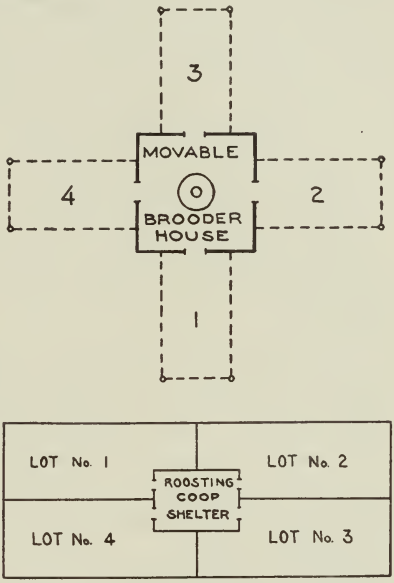

Fig. 38.—Two systems for rotation of runs suggested by Billings for prevention of blackhead.

Regardless of the system used in rearing turkeys, the following precautions against blackhead must also be observed:

1. Keep the turkeys entirely separated from the chickens or chicken yards. Drainage from chicken yards to turkey yards is a common source of blackhead.

2. Do not rear turkeys on ground that has been fertilized with chicken or turkey manure.

3. Do not rear turkeys in yards where losses from blackhead have occurred until at least one year has passed after the removal of the last diseased bird.

4. Do not introduce new stock without quarantining it for three weeks before adding it to the flock.

5. Feed an adequate ration, with plenty of fresh, clean water.

The continual feeding of tobacco dust mixed with the mash as a preventive has been suggested by several experiment-station investigators. The principle of this plan is to prevent cecum worms from becoming established in the flock and thus to reduce the chances of transmission of the blackhead parasite by this means. Scott[41] recommends adding 4 pounds of tobacco dust containing at least 2 per cent nicotine to each 100 pounds of mash; this mixture is to be fed continuously from the time the poults are transferred from the brooders to the range. *Such measures are not recommended for general use where blackhead can be readily*

[41] Scott, H. M. [As told to T. B. Avery.] Kansas controls blackhead by feeding tobacco dust. Turkey World 10(5):10, 12, and 48. 1935.

controlled by other methods not involving drugs. In certain instances where poults cannot be reared free of the disease by a sanitary plan alone, tobacco dust deserves a trial. Before feeding it, however, one should definitely determine that blackhead and not some other disease is causing the losses.

COCCIDIOSIS

Mortalities in young turkeys are often mistakenly ascribed to coccidiosis when some other disease is really responsible. Most of the cases of bloody diarrhea, a common symptom of this disease in chickens, which are attributed to coccidia by turkey growers, feed salesmen, and others are not caused by these parasites.

Only two species of turkey coccidia have been described: *Eimeria meleagridis,* and *E. meleagrimitis.* Neither species is pathogenic for chickens, and none of the six species of coccidia described for chickens has been definitely shown to be pathogenic for turkeys. For a complete description of these organisms the reader is referred to Tyzzer and Becker.[42]

Symptoms and Mortality.—The symptoms of coccidiosis in turkeys differ considerably from those often seen in acute outbreaks of the disease in chicks. When trying to diagnose coccidiosis, therefore, one should not attempt to compare the symptoms of turkeys with those seen in chicks. The presence of the disease is strongly suggested by listlessness, drooping wings, ruffled feathers, and a light brownish diarrhea with considerable mucus.

Under good management and sanitary conditions, coccidiosis apparently does not cause severe mortality in turkeys. Although heavy losses have been associated with the disease, some contributing factor such as insanitary surroundings or inadequate diets has been observed in the outbreaks studied. Poults being reared by turkey hens have suffered more losses, in the experience at this station, than those being reared by artificial means, probably because the mother hen may continually eliminate large numbers of coccidia.

The following example illustrates how mortality from the disease can, without treatment, be reduced to a minimum by careful attention to sanitation. During the three years 1932, 1933, and 1934, 4,020 poults were hatched from the regular flock at the University Farm with a mortality to thirty weeks of age, from all causes, of 573, or 14.25 per cent. Although every poult that died during this period was subjected to a

[42] Tyzzer, E. E. Coccidiosis in gallinaceous birds. Amer. Jour. Hyg. 10:269–383. 1929.
Becker, E. R. Coccidia and coccidiosis of domesticated game and laboratory animals, and of man. 147 p. 25 fig. Collegiate Press, Inc., Ames, Iowa. 1934.

careful autopsy, coccidia were demonstrated in only 152. Of these only 87 had infections severe enough to account for death. Thus the average mortality from coccidiosis for a three-year period was only 2.16 per cent. Coccidia were never demonstrated in poults that died before the fifth week after hatching. The largest number of deaths occurred from the fifth to the sixteenth weeks, inclusive.

Autopsy Findings.—Catarrhal enteritis, especially in the lower half of the intestine, and the presence of yellowish-brown fecal matter in the ceca are common autopsy findings in cases of coccidial infection. Hemorrhagic enteritis is the exception rather than the rule. In marked cases the intestine may be filled with whitish-gray semigelatinous pus containing myriads of coccidia. This exudate adheres to the intestinal wall and leaves a denuded area when scraped from the surface. Only by microscopic examination can coccidiosis be successfully diagnosed.

The Carrier Problem and Possible Transmission Through the Egg.—Adult turkeys that have died from other causes or that have been killed for market have been examined and found, occasionally, to be harboring coccidia in the intestines. This fact suggested the possibility of adult carriers, and studies were initiated to determine whether normal adult turkeys could spread the infection. The preliminary results and observations are given below.

At the beginning of the 1933 hatching season, 122 breeders of the University Farm flock were placed in individual wire-bottomed cages, previously washed and disinfected. Feces were collected over a period of at least 3 hours. Before each bird was placed in the cage, its feet were washed and scrubbed free of fecal matter. The feces were collected and examined by a flotation method based on that used by Spindler[43] for examining soil samples for the presence of worm eggs. A total of 43 (35.24 per cent) were found to be shedding large numbers of coccidia; the remainder, none or a relatively small number. An attempt to segregate the birds into negative and positive groups was made. Many of the birds, however, though not shedding oöcysts at the time of the individual fecal examination, were nevertheless carriers, since subsequent composite samples from each pen showed all but one of the eight pens to be infected.

The original plan for hatching eggs from the negative and positive groups separately had to be abandoned, but for ten weeks feces were examined after each hatch at weekly intervals. The hatching tray of each incubator was covered with a cloth to collect the feces from the

[43] Spindler, L. A. On the use of a method for the isolation of ascaris eggs from soil. Amer. Jour. Hyg. 10:157–64. 1929.

poults up to the time of removal to the brooders. This was the first sample to be examined. In four hatches, totaling 1,100 poults, no coccidia were found in the initial samples. No coccidia were found until the end of the sixth week in hatch 1 and until the fifth week in hatch 2. Beginning with hatch 3, coccidia began to appear in the feces in the third and fourth weeks; but by that time large numbers of infected poults from previous hatches were in the brooder house.

A similar plan was followed for the 1934 season except that after the first hatch cloths were not used, and the first coccidial examination was made after the poults had been in the brooder house for 3 to 5 days. Six hatches, a total of 1,950 poults, were examined; and all initial samples were negative for coccidia. Again, the first two hatches remained free from coccidiosis for over a month and the others for at least two weeks after being placed in the brooder house. According to these data, turkey coccidiosis is not transmitted through the egg. These observations agree with those reported by Tyzzer.[44] The fact that a high percentage of the poults passing through an outbreak of coccidiosis apparently become carriers and eliminate large numbers of coccidia in their droppings, probably explains why coccidiosis is not easily prevented from establishing itself in the annual crop of poults.

Two types of experiments designed to demonstrate the possibility of the mechanical transmission of coccidiosis from the breeding flock to the poults have been completed at this station. One of these, conducted to determine how far coccidia can be carried by a person visiting an infected yard, proved by repeated trials that coccidia oöcysts can be carried as far as ½ mile on the soles of shoes and still remain capable of sporulating and producing disease. The second experiment was conducted to determine the possibility of transmitting coccidiosis by contaminated feed. Sterilized feed that was walked on, in the process of being mixed, by attendants who had previously visited infected yards, produced coccidiosis when fed to susceptible birds. Judging from the experiments on egg transmission and on mechanical transmission, coccidia are most likely to be carried mechanically from adult carriers to poults being brooded artificially.

Transmission to poults reared by turkey hens, however, is a different problem; obviously a group of poults brooded by a mother hen constantly eliminating coccidia stand little chance of escaping infection. This fact explains why it is often more difficult to control coccidiosis in turkey-hen-reared poults than in brooder-reared stock.

Prevention, Control, and Treatment.—Prevention of coccidiosis in

[44] Tyzzer, E. E. Personal communication, March 14, 1935.

turkeys is best accomplished by preventing contact of the poults with the adult stock. As already stated, it is impossible to prevent coccidiosis in poults reared by carrier turkey hens. Keeping the individual broods well separated will, however, aid in stopping the spread of the disease, since usually only a portion of the adults are carriers. Although information on the immunizing properties of small doses is not available, apparently turkeys become immunized by eating small numbers of coccidia. Moving the brood frequently, therefore, and keeping the ranging area dry may aid in immunizing the poults and thus be an important preventive procedure.

In artificial brooding, preventive measures are more practicable than when turkeys are brooded naturally; but two important avenues of infection exist—namely, the feed and the attendant. Indirectly, the attendant is a carrier of coccidia by way of feed, especially if he shovels it from one pile to another on a floor, since he cannot avoid walking on feed mixed in this manner. Visitors are also potential mechanical carriers.

Buying day-old poults from reliable hatcheries and using artificial brooding methods are to be recommended for the turkey grower who has a badly infected flock of adult turkeys. In such instances all adult stock should be disposed of several weeks before the poults are purchased, and the poults should be reared in houses and yards that have not been used for the adults. This procedure eliminates the most important source of infection, the adult turkey.

Coccidia oöcysts must have moisture in order to form spores, without which they cannot produce disease. Keeping thoroughly dry all area to which poults have access will do much, therefore, to prevent acute outbreaks. Frequent changing of litter, the use of wire-screened platforms for water and feed containers, and ample floor space, are aids in keeping the floors of the brooder houses dry. The methods suggested for preventing blackhead will also aid in preventing coccidiosis.

Control of the disease in acute outbreaks may be accomplished by rigorous dry cleaning at daily intervals. Feeding a 40 per cent dried-milk mash may aid in the control program, but greater effort must be made to keep the floors dry while the milk treatment is used. A laboratory diagnosis must be obtained before this treatment is begun, because the treatment may cause severe losses in some types of enteritis not due to coccidiosis. It should continue only while justified by the response of the birds and should stop immediately if heavy losses are experienced. *The use of drugs is not recommended.*

INTESTINAL TRICHOMONIASIS[45]

The true significance of the one-celled flagellated protozoön parasites known as trichomonads, as disease producers in turkeys is not known. Many species have been described as associated with losses, but only one, *Trichomonas diversa,* has been shown definitely to be the causal agent in a disease of turkeys. This species is found associated with trichomoniasis of the upper digestive tract, which is described in the next section.

For years, turkey growers in California have experienced severe losses from undiagnosed causes among poults from six to ten weeks of age. In many of these outbreaks trichomonads were observed; but because of the general opinion that they were normal inhabitants of the intestines, diagnosticians did not consider them as a possible factor in causing the mortality. In 1933, increased numbers of cases, with typical clinical and pathological characterizations, were received at various diagnostic laboratories. In 1934, 1935, and 1936, outbreaks were epidemic in nature in several turkey-growing sections of the state. The average mortality was in the neighborhood of 50 per cent of the entire affected brood. Many growers lost 75 per cent of their turkeys during the brooding season.

Although preliminary attempts at infecting poults with the parasites have been successful, the experimental disease picture has not been the same as that seen in the field. This fact makes it uncertain whether trichomonads are responsible, and much intensive research will be necessary to determine their exact relation to the disease.

Symptoms.—Listlessness, sagging of the wings, a general unkempt appearance, and watery, foamy droppings are the principal symptoms. Cecal discharges vary with the feeding methods, but are usually yellowish brown, foamy, and semiliquid. No bloody diarrhea has been observed. Enormous numbers of trichomonads can be seen when a drop of the foamy liquid droppings is examined with a microscope.

The course is rapid, usually a matter of hours, although the sick poults may linger 2 or 3 days. Just before death, they rest on their haunches with their heads lying on or under a wing. Slight convulsions usually precede death.

Autopsy Findings.—The crop is nearly always empty. The general condition of the poult indicates that it had not eaten for some time before marked symptoms appeared. When the poult lives for a few days, it rapidly becomes emaciated. Gross internal lesions are confined to the intestinal tract, although the gall bladder is constantly enlarged.

The entire intestine lacks tone, appears thin-walled, especially pos-

[45] Gierke, A. G., and W. R. Hinshaw. Mortality in young turkeys associated with trichomoniasis. Jour. Amer. Vet. Med. Assoc. 41(n.s.):76–80. 1936.

teriorly, but shows few indications of inflammation. Occasionally, sections of the intestine below the duodenum are bulbous and slightly congested. The contents are liquid or semiliquid and contain many gas bubbles. The cecal contents may be liquid or semiliquid and contain considerable gas.

Microscopic Findings.—Myriads of trichomonads can be demonstrated in the contents of the lower intestine and ceca. Systematic examination of scrapings of the entire digestive tract from the mouth to the anus have been made on poults from several outbreaks. In all instances, the parasites have been confined to the lower one-third of the intestine. If found in the upper two-thirds of the intestine, they are usually confined to the bulbous inflamed areas. They have not been found in the blood-stream nor in other tissues of the body by examination of fresh materials.

The species of *Trichomonas* is as yet unnamed. The parasite is small in comparison with other species from man and animals, having a size range of 4 to 12 microns in length by 3 to 5 microns in width, with an average of 9 by 4 microns.

Bacteriological studies consisted of plating of heart blood, liver tissue, and—in dead birds—bone marrow, on meat extract, cooked blood agar, and an infusion medium made from turkey meat and liver. All these studies have yielded negative results. A limited number of anaerobic studies have also resulted negatively.

Blackhead lesions have not been associated with any of the outbreaks studied, and *Histomonas meleagridis* has not been recognized in the microscopic preparations.

Transmission.—The parasites are readily transmitted to young turkeys and day-old to week-old chicks, but not at all to older chicks. So far it has been impossible to reproduce the disease, as seen in the field, by artificial inoculation either with cultures or with infected material from turkeys. Once infected, turkeys remain carriers for at least three years and shed the parasites in their feces.

Epidemiology.—Field studies have shown that management plays an important rôle. The disease usually starts in a community on a ranch where some contributing factor such as low fertility, poor hatchability, or insanitation exists.

Invariably, adult birds have been on the premises in these initial outbreaks. In at least two outbreaks, adult birds were shedding large numbers of trichomonads, although they appeared normal.

This condition has existed in every community observed by the writer; and usually the disease has spread in true contagious form, probably

helped by the traffic from infected to noninfected farms. A survey of ranches in infected areas, that have had no losses, suggests two factors that may account for their success: one is complete isolation of growing from adult stock; the other is better management.

Added evidence that trichomonads play an important part is that only in those outbreaks having the clinical picture, and characterized by the pathological findings reported, have they been found in any number. Since these observations were started, trichomonads have been carefully sought in all specimens brought to the laboratory for diagnosis.

Baby ducks and baby chicks were found associating with diseased turkeys without apparent ill effects. On another ranch 10-day-old chicks cared for by the same person who looked after the turkeys showed no symptoms, and a few examined were negative for the parasite. Several other ranches reported chicks on the same premises without losses.

Prevention and Control.—Obviously, until more is known about the life history of the parasite and its exact rôle in the disease, no satisfactory control program can be developed. Certain observations made during the past few years, however, justify the following suggestions on prevention and control. These precautions can be applied equally well to many other poult diseases.

1. Avoid all contact of poults with chickens and adult turkeys.
2. Brood by artificial means on new ground or with brooder equipment having cement floor or wire platforms in both the houses and yards. Purchase, if possible, the entire brood at one time and early in the season.
3. Use a sane, sound management program. The brand of feed is of little importance. If the feeding method used in previous years was successful, stick to it.
4. Keep visitors out of the brooding pens.
5. Do not visit the turkey yards of any other grower. Discuss your problems with him on the street corner or at his home, not in his turkey yard.
6. If disease breaks out, get an accurate diagnosis. Send or take some of the sick specimens to a diagnostic laboratory, and do not accept a field diagnosis until it has been confirmed by the laboratory.
7. Avoid all drastic treatment until the laboratory diagnostic report is received. The treatment should then be based on the laboratory findings.
8. Observe the precautions for handling an outbreak of disease given on pages 23–25.

It is especially important to segregate the sick birds, and if on range to move the feeding and watering equipment daily. The use of wire platforms for this equipment will be of great help in preventing the droppings, which are the most important means of transmission, from contaminating the feed and water. (See figs. 1 to 3, p. 8, 10). Roosting areas should be moved frequently or screened to eliminate all possible contact with the droppings.

TRICHOMONIASIS OF THE UPPER DIGESTIVE TRACT

(Necrotic ulceration of the crop, Jungherr's disease)[46]

Volkmar[47] has described a species of trichomonad which he calls *Trichomonas diversa,* associated with necrotic ulceration of the crop (Jungherr's disease). More recently Hawn[48] has shown that trichomonads are the causative agent in this disease. As far as is known this species has not been found posterior to the proventriculus. Gierke[49] has described a necrotic ulceration of the upper digestive tract of chickens, associated with a heavy infection of trichomonads similar to those described in turkeys by Volkmar and by Hawn.

Jungherr in 1927[50] was the first to describe this disease. At that time he suggested that a fungus was the probable cause. It was three years later that Volkmar reported that *Trichomonas diversa* is a constant inhabitant of the crops of turkeys suffering from this disease, and as mentioned above, Hawn has since shown these parasites to be the etiological agent.

Epidemiology.—Most of the cases studied by the writer have been in turkeys from sixteen to thirty weeks of age reared on range land. The following description of one outbreak in California is typical of the environment in which most of the cases are found:

The turkeys involved in this outbreak had been reared on the home ranch under semiconfinement methods until the middle of September, when they were driven daily to a cutover rice field about ½ mile from the ranch. Each day the birds were allowed to feed for 2 or 3 hours on the shattered rice left by the harvester. After this procedure had been continued for about a month, the flock was permanently moved to the rice field and allowed to range at will. They were fed a mash supplement that was left near the roosts located on a dry area in a cutover barley field adjacent to the rice. Water was hauled from the home ranch; but the birds had access to the sluggish, algae-infested water in an irrigation ditch, which they had to cross in order to reach the rice from the roosting and mash-feeding areas. A seepage from the ditch had caused a large, muddy stagnant pool to form near the edge of the rice field; the turkeys

[46] The name of "Jungherr's disease" was first suggested by F. R. Beaudette in New Jersey Agr. Exp. Sta. Rept. 1930–1931:334.

[47] Volkmar, F. *Trichomonas diversa* and its association with a disease of turkeys. Jour. Parasitology 17:85–89. 1930.

[48] Hawn, M. C. Trichmoniasis in turkeys. Jour. Infect. Dis. 61:184–97. 1937.

[49] Gierke, A. G. Trichomoniasis of the upper digestive tract of chickens. California State Dept. Agr. Mo. Bul. 22:205–8. 1933.

[50] Jungherr, Erwin. Two interesting turkey diseases. Jour. Amer. Vet. Med. Assoc. 24(n.s.):636–40. 1927.

drank a great deal of this water and picked up the rice in the mud at the edge of the pool. Several similar pools were found in other parts of the field. The disease started within 10 days after the birds were permanently located on the rice field.

Stagnant pools of water in undrained areas of range lands, such as the one described above, are frequently associated with outbreaks of this disease in California.

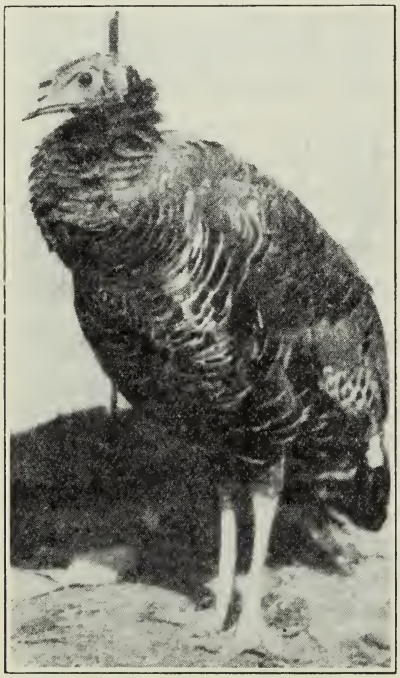

Fig. 39.—Posture typical in trichomoniasis of the crop. Note especially the sunken appearance of the crop area.

Symptoms.—The symptoms are similar to those seen in many other diseases. Darkened heads with sunken sinuses and a generally haggard appearance are characteristic. The chest always has a depressed appearance, with the crop empty and drawn in towards the body. This typical attitude is seen in figure 39. Lack of appetite, drooling at the mouth, roughened unkempt feathers, and a normal or slightly subnormal temperature are also observed. Diarrhea does not, as a rule, accompany the disease. A foul odor is always present.

The course of the disease varies; but, as a rule, it is prolonged, and the birds become emaciated before death.

Autopsy Findings.—Chronic ulceration of the crop is the most common autopsy finding. The lower esophagus and, less often, the proventriculus and upper esophagus may also be involved. The lower digestive tract and the other organs are, as a rule, normal. Aspergillosis of the lungs may be secondary to the necrotic ulceration of the upper digestive tract.

The lesions involve the glandular tissue and vary in size from a few to 15 millimeters in diameter at the base (figs. 40–41). They taper to a point in concentric rings of piled-up necrotic tissue to as much as 5 millimeters above the surface. They may extend into the tissue as much as 3 or 4 millimeters. The surface protruding into the lumen of the organ is rough, irregular, and surrounded at the base by a circular hemor-

rhagic ring. Those in the esophagus are usually smaller than those in the crop but are similar in shape and structure. When the proventriculus is involved, the esophageal portion is most affected. The lesions in the pro-

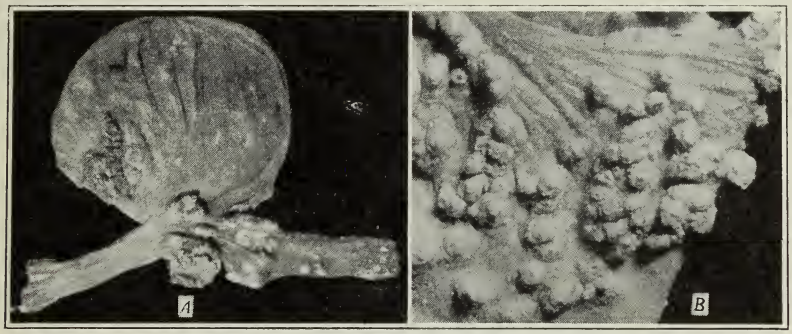

Fig. 40.—*A*, Necrotic ulceration of the esophagus and crop seen in trichomoniasis of these organs; *B*, close-up of typical pryamidlike necrotic ulcers characteristic of trichomoniasis of the upper digestive tract.

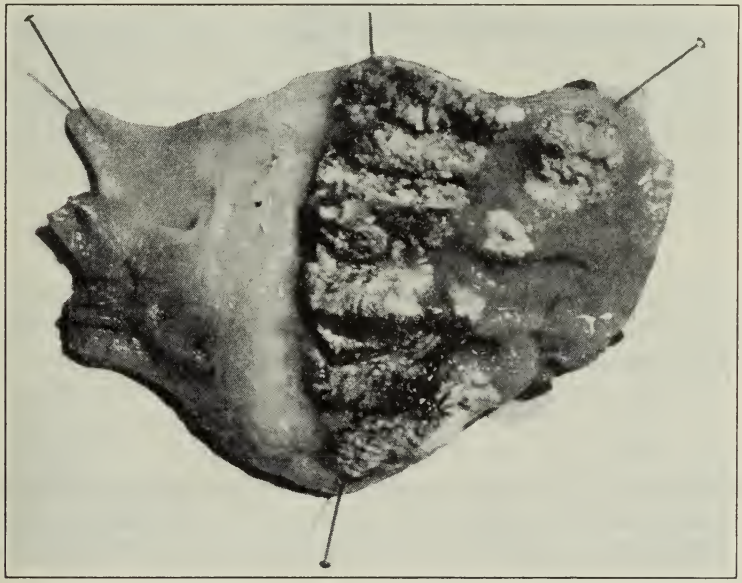

Fig. 41.—Necrotic ulceration of the proventriculus often seen in trichomoniasis of this organ.

ventriculus are, as a rule, coalesced and may appear to be a solid ring of necrotic material causing a marked thickening of the tissues and resulting in partial to complete occlusion of the lumen. In many such cases, impactions of the lower esophagus have been noted.

Prevention and Control.—Since the disease appears to be one directly

associated with insanitary surroundings, sanitation is of primary importance. In addition, adequate supplements must be fed to all turkeys being ranged on cutover grain fields.

The disease can be prevented by keeping turkeys away from known infected areas and by avoiding as range lands poorly drained fields where stagnant pools of water exist or where birds have access to stagnant, sluggish irrigation ditches. Old strawstacks that have become decomposed should be avoided, as should areas of grain fields that have been beaten down and covered with water for any length of time.

The first requisite for control is also sanitation. As soon as the disease is observed, the flock should be moved to a dry, clean area and given plenty of pure, fresh water to drink. The feed should be checked to see that it is free from molds, and all access to old strawstacks, muddy trampled feed areas, and stagnant water prevented. Sick birds should be kept separate and cared for by a person who has no contact with the well birds. Removing the causative agent and giving the birds good care is more essential than treatment with drugs. The use of a 1–2,000 solution of copper sulfate (bluestone) in place of all drinking water is the only treatment tried by the writer that has met with any success. (See p. 37 for method of preparation.) If copper sulfate solution is used, it should be kept before the birds for 2 or 3 days and then repeated after a few days, if improvement has not been noted. All other sources of water should be removed during such treatment.

MISCELLANEOUS DISEASES

This section includes diseases and conditions which cause considerable financial loss in certain flocks but which are more or less sporadic in nature and whose cause is unknown.

ABSCESS OF THE FOOT PADS

(Bumblefoot)

Turkeys sometimes suffer from abscesses of the foot pads (fig. 42). These may resemble corns and are similar to a condition, commonly called bumblefoot, in chickens. The cause is not known, but the abscess probably starts from an infection following an injury to the foot pad. Some of the cases observed by the writer have resembled foot rot as seen in other animals. In these instances the affected turkeys had been in yards that were in constant use and which were covered with several months' collection of feces; cases usually appeared after the fall rains when the yards became very muddy. No doubt many cases of abscesses of the foot pads are also identical with staphylococcal arthritis (p. 65).

Putting the affected birds in clean, dry quarters and using tincture of iodine daily on the diseased pad will cure many cases. Pus should be removed, and the wound treated with iodine.

Rotating the runs and removing the birds to a clean, well-drained yard just before the rainy season are recommended as preventive measures.

Fig. 42.—Abscesses of the foot pads (bumblefoot).

ENTERITIS (NONSPECIFIC)

(Inflammation of the intestines)

Every year numerous immature turkeys die of enteritis from unknown causes. Further research, possibly, will prove some of these outbreaks to be infectious in nature. At present, however, they must be handled as noninfectious and can probably be attributed to a number of causes.

Stampeding, failure of brooder heaters, sudden changes in the weather, piling in the brooder houses, heat prostrations, sudden changes of feeding methods, and probably, in many cases, faulty feeding methods over a period of several weeks, are examples of obscure causes of mortality, with enteritis as the principal pathological manifestation. These various factors may also pave the way for secondary invasion by microörganisms of low virulence, which, under such conditions, may cause heavy mortality.

An example of losses starting from an obscure cause that may easily be overlooked was called to the writer's attention during 1934 at the University Farm. Three lots of turkeys about twelve weeks of age were in similar yards where it had been necessary to use an undesirable watering

system until a modern drip system was installed. This new system was installed in all three yards at the same time, and the old system removed. Within 48 hours two of the three lots of turkeys became ill, while the third remained normal. On the third day it was discovered that the two groups of sick birds were not drinking the water because of an apparent fear of the new equipment. When the old equipment was replaced in these pens, the birds fought to get at the water and drank three or four times as much as normal for the day. Only 1 per cent of the birds died before and within 24 hours after the discovery of the cause, but there was a distinct difference between the two affected lots and the third lot for nearly a month. A difficulty usually experienced in making a diagnosis in such outbreaks is the lack of sufficient history.

Symptoms.—The principal symptoms seen in enteritis are loss of appetite, a tendency to separate from the well birds, diarrhea, and a general haggard appearance. Temperatures are usually normal or subnormal. The birds may sit around in a listless manner with their heads hung or turned up over their backs. On open ranges, where the majority of the flock is affected, difficulty is often experienced in keeping the birds under control; the turkeys appear nervous and may wander for hours, often straying ½ mile or more from the main camp. During the course of the disease, often a period of several weeks, a marked loss of flesh may occur. The mortality is not, as a rule, high for a single day; but over a period of three or four weeks, 25 per cent or more of the birds may die. The greatest loss, however, results from failure of the birds to recover completely and to make proper gains.

Autopsy Findings.—Emaciation and enteritis, varying from a catarrhal to a hemorrhage type, are the principal autopsy findings. The head has a drawn appearance, with the eyes and sinuses sunken. The heart is usually flabby. The blood, in many instances, fails to clot for several hours after death; it is usually very dark in appearance. The liver often appears congested, and dark venous blood oozes from cuts made on its surface. In many respects the symptoms and autopsy findings resemble those of acute poisoning.

Prevention, Control, and Treatment.—It is extremely difficult to give methods of prevention, control, and treatment for enteritis of an unknown cause. Sound, rational turkey husbandry is probably the best preventive. An adequate diet and an ample supply of pure, fresh water are important.

Avoiding the possible causes of enteritis is essential. A few have already been mentioned, and others will suggest themselves. Any abnormality that will cause the bird to lose its appetite or develop an intestinal

disturbance, even for a few days, may cause heavy losses for several weeks.

The successful feeder of any class of livestock realizes the need for constant attention to the flock or herd to detect the first symptoms of failure to make proper gains. Sudden changes of feed should be avoided; but, if the flock is definitely not doing well on a particular diet, the reason should be sought. If the feed is responsible, a gradual change to another method should be made. If the original method is resumed after the birds have recovered, the shift should also be gradual.

A common fault of turkey growers is to supplement an already adequate commercial growing mash with milk, fish meal, or meat scraps, which increases a protein level already near the maximum tolerance for turkeys. If cheaper sources of high-protein feeds than are in a commercial product are available, the feed dealer should be consulted, and a properly balanced feed obtained to mix with the available supply. An equally common mistake and one that may cause very severe losses is to remove all mash supplement when turkeys are moved to barley, wheat, or rice ranges. The first month on a new range is probably the most important one, and no doubt more losses are experienced from failure of the birds to become properly adapted to the new environment than for any other reason. As the average grain field does not contain an adequate supply of all the necessary food elements for proper growth, a supplement is necessary. The most important elements liable to be deficient on a cutover grain field are greens for vitamins A and G and protein concentrate. The amounts of each that are needed will depend on the amount of green grass and insect life available. Each range constitutes an individual problem and must be studied carefully; a suitable concentrate must be furnished the birds.[51]

Turkeys that are to be taken off a full-feed ration and transferred to a grain field should be fed some of the same type of grain as that grown in the field for a week or two before being moved to the range. This procedure accustoms them to the new grain and will prevent a setback and possible heavy losses. In addition, for a few days after they are moved to the range, the birds should have some of the mash previously used.

For control of enteritis, the methods suggested in the section "Handling a Disease Outbreak" (p. 23–25) are recommended. It is especially important that the cause be determined if possible and eliminated.

[51] Information regarding formulas for concentrated mixes to be used as supplements can be secured by writing to Division of Poultry Husbandry, University Farm, Davis, California. History of the previous feeding practices and information regarding the kind of feed available should accompany the request.

HEAT PROSTRATION

(Heat stroke)

Heat prostration is usually associated with high humidity accompanying high temperatures or with very low humidity on excessively hot days. Losses from this cause most often occur in young turkeys that have recently been moved from the brooder house to a range having inadequate shade.

The symptoms are labored breathing, weakness, excessive thirst, and high temperature, followed by complete prostration.

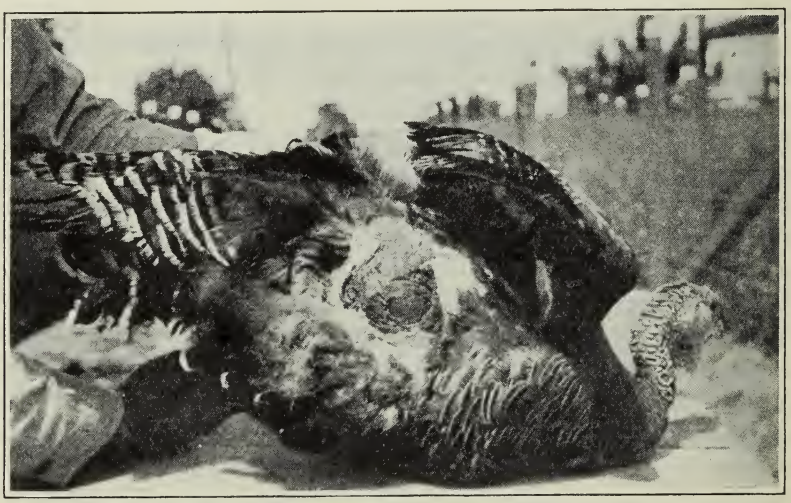

Fig. 43.—Turkey hen with a severe laceration caused by a male during the mating process.

Losses can be prevented by furnishing ample shade facilities, especially for the poults just transferred from the brooder house to an open yard or range. If a house is available on the range, the young poults may well be sheltered in it during the hottest part of the day, but with all the windows open for ample circulation of air. Plenty of water should be available. As soon as the poults become accustomed to the new quarters, they will stay inside during the excessive heat; water and feed should be left both inside and outside the house for the first few weeks. Out of doors, trees make the best shade; but an abundance of cheap artificial shade can be made from old lumber and posts. Thatched roofs may be used advantageously if material for covering the shelter can be secured. Pure, fresh water must be available at all times. It should be kept in a shady place, in enough containers so that the birds will have no difficulty in getting to it.

If, in spite of all precautions, turkeys are overcome by the heat, they should be put in a shady, well-protected place and sprayed with cold water. Used in time, this procedure will save a large number. Filling the crop with cold water by means of a rubber tubing and a funnel is also advisable. Dipping the birds in cold water may be effective, but care must be taken to prevent drowning. As they may remain weak for several days, they should be kept in the shade with food and water easily accessible.

Fig. 44.—*A*, A method of trimming the toenails of a male turkey to prevent injuries during the mating season; *B*, feet of a male turkey after trimming the toenails as illustrated in *A*.

INJURIES

Many types of injury cause losses in turkey flocks, and the value of an injured bird often warrants individual treatment. Some of the more common injuries are described below.

Injury of the Female by the Male.—Severe losses occur in many breeding flocks because of the female's being badly torn by the male during the mating process (fig. 43). Badly torn females seldom recover sufficiently to produce fertile eggs during the remainder of the season; and if the wound does heal, the area is tender and easily torn when the bird is trodden again.

Some males are much more vigorous and rough in the mating than others, and many of the losses can be traced to one or two individuals in a flock. These males should immediately be replaced by reserves. One method of prevention is the removal of the toenails from the males (fig. 44). This should be done about a week before the males are put into the breeding pens. A convenient instrument for removing the toenails is a pair of pruning shears of the roll-cut type shown in figure 44*A*. An electric soldering iron or some other form of a searing iron can be used for searing the cut surface to stop hemorrhage after the operation. It is a good plan to smooth off the edges of the cut surface with a file or sandpaper just before the male is placed in the breeding pen.

Another method of preventing breeding females from being torn is to fit a canvas jacket over the back (figs. 45–46). These jackets, which can be purchased at a reasonable price, may be of value in flocks where considerable difficulty is being experienced. If they cannot be used on all the birds, a few can be kept on hand for females that are torn in spite of the removal of the toenails.

Fig. 45.—A type of "apron" or "saddle" in common use for prevention of injuries to females during the mating season. See figure 46.

If an injured hen is discovered immediately, the torn edges of skin should be sutured with a heavy thread dipped in iodine. The bird should then be placed in a pen where there are no males and left for about two weeks. An antiseptic dusting powder such as boric acid, sodium perborate, or iodoform will induce healing and prevent attacks by flies. As soon as the wound begins to heal normally, the hen can be fitted with the canvas jacket described above, and can be returned to the breeding pen. She should be carefully watched, however, and if molested by the males should be returned to the isolation pen.

Wounds that are not discovered for several days seldom respond well to treatment. They should be carefully cleaned and washed with a mild antiseptic solution and treated with an antiseptic dusting powder. It may be necessary to make an incision in the skin below the wound for drainage and to trim necrotic edges of the skin around the wound. The birds should be kept out of the breeding pens for two or three weeks and treated daily. They should be jacketed before being returned. Where several males are in one pen, the transfer of a male to a pen of injured females may be a better procedure than putting the injured hens back in the regular pen. The time required for complete recovery depends on the extent of the injury and the efficiency of the treatment. Whether or not treatment is worth while depends on the value of the individual and the time available.

Injuries from Fighting.—As males are more liable to be injured from fighting than are females, often a valuable male should be separated from its penmates if it is getting the worst of a bargain. A male which has been away from the flock for any length of time or which has just

been purchased must be protected when placed with other males, because they will invariably fight it.

Minor injuries seldom require treatment and will heal readily if the bird is unmolested. Severe lacerations about the head usually respond to iodine or an antiseptic dusting powder. If flies are troublesome, carbolized vaseline can be used to cover the wounded areas.

Miscellaneous Injuries—Injuries from being caught in fences, from flying into objects during stampedes, from rough handling, and from many other causes are cared for in much the same manner as injury by a male.

Fig. 46.—Turkey hen with the "saddle" shown in figure 45 in place.

A type of injury seen a few times by the writer is shown in figure 47; the bird is usually found with its head hanging downward and forward and is unable to change this position. The neck muscles are much swollen and are hot to the touch. Often one will find a tuft of feathers pulled from the side of the neck and evidence of a bruise. Dislocation of a vertebra or fracture of a vertebral process has been found to be the difficulty in most cases. In at least two, the injury resulted from entanglement in a wire fence during attempts to reach feed. Correction of the dislocation by massage and tension gave relief and complete recovery in about two weeks. Other cases have taken from three to six weeks to recover but have shown no detrimental after-effects.

If such an injury is found in a flock, the cause should be determined. Any dislocation found should be corrected. A valuable bird should be taken to a veterinarian. Until recovered it should be isolated but placed near water and feed containers.

LARYNGITIS

This condition should not be mistaken for infectious laryngotracheitis, a common disease of chickens but one to which turkeys are resistant. Adult turkeys, however, are especially susceptible to a mild laryngitis. The most pronounced symptom is the "rattling in the throat" caused when air passes over a mucous deposit in the upper trachea. This is more pronounced when the bird becomes excited, and at times the effects of the irritation and mucous deposit may cause choking. The disease does not appear to be very contagious and can best be controlled by a careful culling of the affected birds—a method that has completely eliminated laryngitis from one flock under the writer's observation for several years.

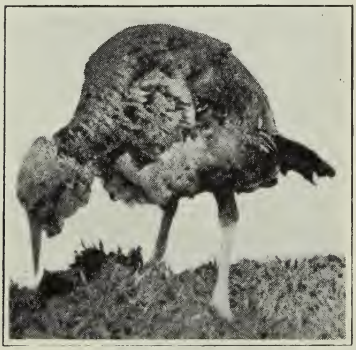

Fig. 47.—Posture of turkey suffering from a slight dislocation of one vertebra of the neck. The bird could not raise its head and the muscles of the area were severely swollen.

OMPHALITIS

Omphalitis, or navel infection, is characterized by a failure of the navel opening (umbilicus) to close properly, with a resultant infection of the internal organs. The disease can usually be traced to faulty incubation or to hatchery insanitation. In most instances the poults are weak when removed from the incubator, and losses may start before time for shipment from the hatchery.

The symptoms are general weakness, lack of body tone, and a tendency to huddle. In the brooder the poults appear cold and stay under the hover. When handled they feel flabby, the abdomen is enlarged, and they do not have the firmness of a normal poult. The navel opening, which usually is completely healed within 72 hours, is inflamed, moist, and fails to close for several days. Often a definite scab forms over the opening. The course is rapid, death often occurring within a day after symptoms are noted; and the mortality is high, often reaching 50 per cent of the brood.

On autopsy an edema of the muscles of the abdomen and breast, an unabsorbed yolk, and peritonitis are the principal observations. The contents of the retained yolk are usually more liquid than normal, and rupture of the yolk sac is common.

The disease is probably a result of a mixed infection, of hatchery origin. In the outbreaks reported to the writer, a thorough cleaning and

disinfection of the hatchery rooms and incubators has prevented further losses. The formaldehyde fumigation method outlined under the section "Disinfectants" (p. 17–19) will eliminate the disease from the hatchery.

No remedy or adequate method of controlling the disease in the brooder has been found. Keeping the poults comfortable and applying hygienic measures (see p. 23–25) will help reduce the mortality to a minimum.

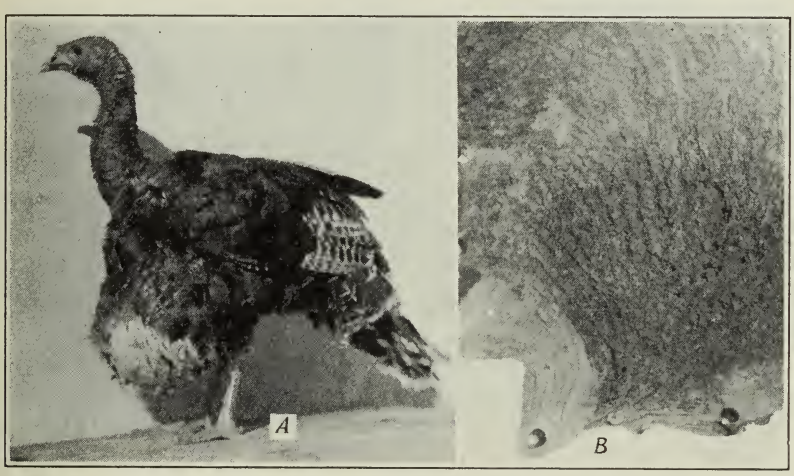

Fig. 48.—*A*, An eight-month-old female turkey with a pendulous crop of about five months' duration; *B*, section of a pendulous crop showing thickening and ulceration of the mucous membrane.

PENDULOUS CROP[52]

(Water crop, drop crop, baggy crop)

Serious losses from pendulous crop (fig. 48, *A*) in some flocks are, according to recent investigations at this station, apparently the result of a hereditary predisposition towards the condition. Turkeys with the inherent weakness develop pendulous crops after the increased liquid intake that follows the first wave of excessive hot weather. The crop, once expanded, seldom returns to normal size, especially if the hot, dry weather continues. It may contract for a few days, if the weather becomes cool, and then expand again during the next hot spell. Although a few birds recover, the majority continue to have pendulous crops. In this condition the crop does not empty normally; stagnant, sour liquid contents are retained in the bulbous portion. As time goes on, the mucous membrane thickens and may become ulcerated (fig. 48, *B*).

[52] Hinshaw, W. R., and V. S. Asmundson. Observations on pendulous crops in turkeys. Jour. Amer. Vet. Med. Assoc. **41**(n.s.):154–65. 1936.

Although the appetite is not greatly affected, digestion is hindered. The feed and water remaining in the crop may increase until the crop and its contents equal one-fourth of the total live weight of the bird. The bird may continue to grow, but will remain unthrifty and may become emaciated.

Pendulous crops caused by an inherent weakness must be distinguished from similar conditions that sporadically result from impactions, mycosis, trichomoniasis, and other crop infections.

Course, Mortality, and Causes of Death.—The course of the disease is chronic; as mentioned above, very few birds recover even with treatment. Some live for as long as two years, but the mortality of the affected birds in a flock may exceed 50 per cent.

The causes of death are (1) rupture of the crop by the bird's toes in its attempt to walk or run, (2) mechanical pneumonia from the seepage of crop contents into the bronchi during mechanical efforts to drain the crop or as a result of a back-flow when the bird lowers its head, and (3) emaciation due to insufficient intake of food or to improper digestion of food.

Necrotic ulcers, varying in nature according to the type of the contents and severity of the case, frequently occur. Scraping the necrotic membrane from the surface leaves a denuded, bleeding area. This type of necrosis is distinguished from that seen in trichomoniasis by the tendency of the latter to form individual pyramid ulcers as compared with the diffuse, spreading nature of the former. Demonstration of trichomonads furnish a further means of differentiation. In a few cases, lesions typical of moniliasis (thrush) have also been observed. In these cases fungi are readily demonstrated. The contents of the crops have varied from a watery, sour-smelling mass to a solid bolus of mud, feces, and grain. Semiliquid contents have been most common. The contents usually suggest a depraved appetite.

Autopsy Findings.—Few or no changes in any organ except the crop and possibly the lower esophagus are seen on autopsy. The mucous membrane of the bulbous portion of the crop is thickened and in folds. Areas of diseased lung tissue varying in size are easily seen in those cases where the cause of death has been a mechanical pneumonia caused by the entrance of crop contents into the lung. In such cases, also, food particles are found in the bronchi when the latter are carefully dissected. The air sacs are sometimes involved, and foreign matter can be seen, when scrapings from them are examined microscopically.

Prevention, Control, and Treatment.—Since pendulous crops are associated with a hereditary weakness on the part of the individual, ob-

Fig. 49.—*A*, The use of a veterinary stomach pump for douching a pendulous crop; *B*, draining the pendulous crop which had been filled by the method shown in *A*.

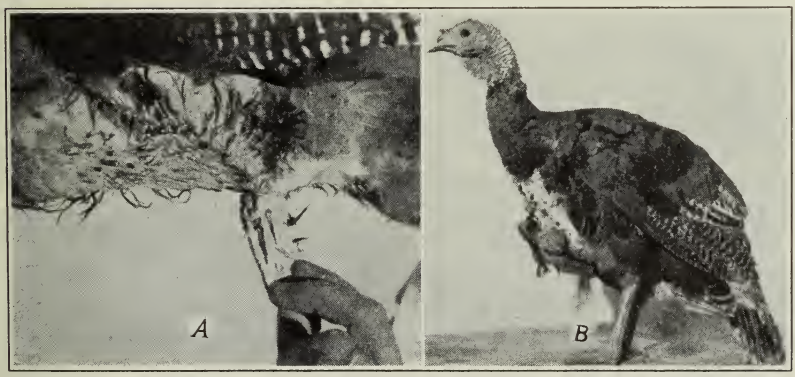

Fig. 50.—*A*, Method of tying off a section of skin to relieve pendulous crop. A suture is passed through the skin and then wound several times around before being passed through the skin a second time and tied. *B*, Turkey three weeks after being treated as indicated in *A*. Note that the tied-off section of skin has become necrotic and is about ready to drop off.

viously the best preventive measure is to avoid mating any birds that have a family history of this weakness. Although this is a difficult procedure in the flock that is not trapnested, much can be done to prevent the condition from becoming established. Poults with affected crops should be caught and toe-marked or banded so that they can be eliminated at the time when turkeys are selected for breeding.

Sufficient shade during the hot months will probably reduce the numbers of pendulous crops in a flock. It is doubtful, however, whether any procedure other than eliminating the inherent tendency will remove the possibility of having a few cases.

Many methods for "curing" pendulous crops have been described by turkey growers. These have included various operations, the use of cloth vests or supporters, and methods of portioning out the water supply to the affected birds. Most of the methods that have come to the writer's attention, however, have produced few or no actual recoveries.

Removing a portion of the crop surgically results in a high percentage of recoveries, but the time consumed probably does not warrant the procedure as a routine practice. Washing out the crop (fig. 49) with warm water containing a weak antiseptic, and then tying off a portion of the skin over the enlarged crop, also yields temporary relief until market time in a small percentage of cases (fig. 50). If only a few cases appear, it is probably more economical to kill the affected birds than to attempt treatment.

POISONING

Although losses from poisoning in turkey flocks are not great, a few cases are briefly described below. The tolerance of turkeys to rodent poisons is also discussed in answer to inquiries on this subject. In most outbreaks traced to poisoning, the symptoms and autopsy findings resemble those already described under the heading of enteritis. The diagnosis depends on discovering poison by chemical analysis of the crop or gizzard contents or on finding poison in the food supply.

Copper Sulfate (Bluestone).—According to experimental work by the writer and W. E. Lloyd,[53] turkeys may be poisoned by copper sulfate added to the drinking water in concentrations greater than 0.2 per cent (1–500 dilution). As turkeys do not like copper sulfate solutions in any dilution and will avoid them if untreated water is present, poisoning is unlikely unless no other source of drinking water is available. In cool weather turkeys may go without drinking for several days rather than drink water containing even nontoxic doses of this chemical. For

[53] Hinshaw, W. R., and W. E. Lloyd. Studies on the use of copper sulphate for turkeys. Poultry Sci. 10:392–93. 1931.

these reasons, copper sulfate is not recommended except for specific uses and in concentrations not exceeding 0.05 per cent (1–2,000 dilution). The poisoning is usually evidenced by a greenish-blue stain on the crop. Marked erosion of the mucous membranes follows excessive doses.

Poisonous Weeds.—The fact that turkeys are often ranged among poisonous weeds suggests the reason for losses that are sometimes experienced on pasture lands. There are no experimental data available, however, on weed poisoning in turkeys. Where heavy losses occur in young turkeys reared on pasture, poisonous weeds should be sought as a possible cause. Suspected plants should be sent to a diagnostic laboratory along with diseased specimens for diagnosis and identification.

As a rule, animals or birds will not eat poisonous plants unless other forms are not available. Most cases of poisoning result from the eating of young, growing shoots that come up in the spring before more palatable and nonpoisonous varieties appear. Under certain conditions the seeds of poisonous plants may cause losses if accidentally mixed with grains.

The only method of control is to remove the cause. If the birds are ranging in suspected areas, confining them in enclosures for a few days and supplying them with sufficient freshly cut greens is recommended. When they are again turned out on the range, the supply of fresh greens should be continued until the suspected poisonous plants have been replaced by nonpoisonous varieties.

Sodium Bicarbonate (Baking Soda).—Sodium bircarbonate has been shown by several investigators (Delaplane, Hoffman, and Witter)[54] to cause losses in chickens. These losses are manifested by lesions in the kidneys and other organs similar to those seen in gout. Hoffman found that the continuous use of amounts of sodium bicarbonate in excess of 15 grams per gallon of drinking water are toxic for baby chicks if used as a substitute for all other drinking water.

No reports on the possible toxicity of this chemical for turkeys are available; but on the basis of the reports on its toxicity for chickens, turkey growers should avoid its use.

Sodium Chloride (Common Salt).—One outbreak of enteritis in turkeys about two-thirds grown finally proved to be associated with the use of well water containing a high percentage of common salt. This was the only source of water, and the losses probably resulted from heat prostration combined with salt dehydration: the turkeys did not like the water

[54] Delaplane, C. F. Some of the tissue changes in poultry resulting from the ingestion of sodium bicarbonate. Vet. Alumni Quart. [Ohio State Univ.] 21:149–66. 1934.
Hoffman, H. A. Unpublished data, used by permission.
Witter, J. F. A preliminary report on the injurious effect of sodium bicarbonate in chicks. Poultry Sci. 15:256–59. 1936.

and drank only small quantities. A supply of fresh water stopped the losses within a few days. Another instance of losses from enteritis probably due to salt eating was traced to boxes of salt placed on the range for sheep that were being pastured with the turkeys.

Strychnine.—Inquiries on possible poisoning by the strychnine-coated grain used for rodent control on cutover grain fields stimulated a series of experiments to determine the tolerance of turkeys for strychnine. To judge from the results,[55] turkeys will tolerate the usual amounts of strychnine in poisoned grain. Despite considerable variation in individual tolerance, there is probably little danger provided other grain is available. Turkeys dislike grain coated with even minute amounts of strychnine and, after the first taste, will usually leave the planted poison bait alone and hunt for more palatable food.

Miscellaneous.—Many other poisons could be mentioned; but they are not common causes of losses, and little is known on the exact tolerance of turkeys to them. Circumstantial evidence often points to poisoning when it is difficult to prove that a particular poison is responsible. Such chemicals as mercuric bichloride, lead arsenate, and thallium, used occasionally on the farm, should be stored out of reach of turkeys. While chemical sprays or dusts are being applied in orchards where turkeys are ranging, the birds should be removed. After the orchard has been sprayed or dusted, there is still some danger from the residue on the covercrop; and, if other range is available, the birds should be kept out of the orchard for several additional days, or until a rain has reduced the residue remaining on the forage.

SINUSITIS

(Swell head, roup)

In sinusitis, a disease common to turkey flocks, the sinuses of the head become swollen because filled with an exudate of various degrees of consistency. One form of sinusitis can be produced in turkeys by limiting the amount of vitamin-A-carrying feeds (fig. 51). Another type appears to be contagious, although no one has yet discovered the cause. Beach and Schalm,[56] however, have demonstrated that *Hemophilus gallinarum* will produce sinusitis when inoculated into the sinuses of turkeys. A third type results from mechanical injury; a piece of grain, a small amount of mash, or some other foreign body is usually lodged in the affected sinus. As a rule, these mechanical cases are unilateral and

[55] Hinshaw, W. R., and T. I. Storer. Unpublished data.

[56] Beach, J. R., and O. W. Schalm. Studies of the clinical manifestations and transmissibility of infectious coryza of chickens. Poultry Sci. 15:466–72. 1936.

are easily differentiated from the other two types. Of course, all three types may occur in a flock at one time.

Symptoms.—Warnings of the disease are given when birds shake their heads and when discharges are found on the feathers over the wing where the bird has attempted to clean its nostrils. These manifestations are followed by a foaming of the eye secretions and by a marked clear nasal discharge. Swelling of the sinuses and, in advanced cases, a par-

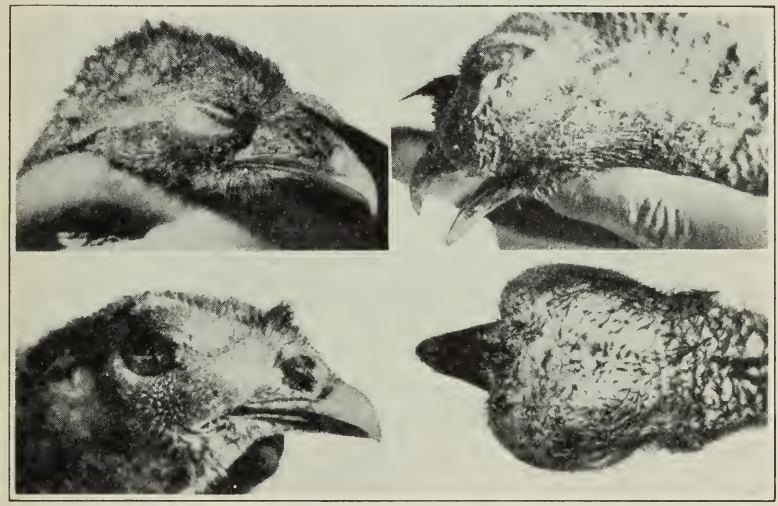

Fig. 51.—Sinusitis experimentally induced by eliminating vitamin A from the ration. The symptoms seen here are identical to those seen in the contagious type. (From *Hilgardia* Vol. 8, No. 9.)

tial to complete closing of the eyes, are the principal symptoms that follow these early signs. The appetite remains good as long as the bird can see to eat. As the disease progresses, the affected birds become thin but seldom show other symptoms. Labored breathing, in some cases, results from respiratory involvement or from a complete closing of the palatine opening because of pressure from the exudate in the sinuses.

As these symptoms are characteristic for all three types of sinusitis, or swell head, final diagnosis depends on the history of the case and on autopsy findings.

Course and Mortality.—Sinusitis of the obviously contagious type runs a chronic course and may exist in a flock for weeks. Although the number of deaths may be less than in some more acute diseases, the financial loss may be greater. Failure to gain weight accounts for as much damage as does mortality.

The course and mortality of sinusitis from vitamin-A deficiency depends on the length of time the ration remains low in vitamin A.

Autopsy Findings.—The filling of the sinuses with exudate and, in a small percentage of the advanced cases, the presence of pneumonia and caseated exudate in the air sacs are the principal lesions. The exudate, in the first stages, is watery in consistency. Then follows a clear, gelatinous exudate which finally becomes caseated and whitish yellow.

In case the sinusitis is associated with vitamin-A deficiency, the lesions described under vitamin-A deficiency (p. 25–28) will also be seen.

Prevention, Control, and Treatment.—An adequate diet containing sufficient vitamin A will eliminate the possibility of sinusitis outbreaks resulting from the deficiency of this vitamin. The same procedure, furthermore, will help to reduce the chance of losses from the so-called contagious type.

Since little is known regarding the cause of the contagious disease, no definite preventive recommendations can be given. As environment seems to play a part in its spread, protection of the flock from unnecessary exposure to drafts, windstorms, and sandstorms should be avoided.

Madsen[57] has reported good results in the control of sinusitis by the use of 1 cubic centimeter (about ¼ teaspoonful) of a 4 per cent solution of silver nitrate injected into the affected sinus after removal of the exudate with the aid of a hypodermic syringe. Dickinson[58] has used a 15 per cent argyrol solution in a similar manner with equal success.

The method consists in withdrawing the gelatinous exudate from the sinus with the aid of a 5 or 10-cc syringe fitted with an 18-gauge needle, 1½ inches long. In the early stages of the disease this exudate is easily reached and removed when one learns the technic. It consists in inserting the needle through the skin and sinus membranes into the filled sinus. Withdrawal of the syringe plunger will remove the semifluid exudate. With a second syringe the remedy (silver nitrate or argyrol) is inserted, and worked through the tissues by a gentle massage. Care should be taken to avoid excessive dosages.

Both these treatments cause considerable swelling of the affected areas, but this subsides within 2 or 3 days, and complete recovery usually takes place within ten days. In severe cases a second treatment may be necessary.

It is essential to administer this treatment in the early stages of the disease when the exudate is in a semigelatinous state. Figure 52 shows the method of inserting the needle for removal of the exudate, and for injection of the remedy.

[57] Madsen, E. E. Reports success in treatment of roup in turkeys. Press release from Utah Agr. Exp. Sta. 1936. Published in San Diego Poultry Journal, Oct. 25, 1936, p. 6.

[58] Dickinson, E. M. Unpublished data.

If silver nitrate solution is used, it is advisable for the operator to wear leather gloves because this remedy is very caustic to the skin.

Surgical removal of the exudate and irrigation of the sinuses with a fresh solution of 15 per cent argyrol or 4 per cent silver nitrate solution may be necessary if the exudate has become caseous. A circular section

Fig. 52.—Method of insertion of the hypodermic needle into the sinus for withdrawal of exudate and inoculation of argyrol or silver nitrate solution.

of skin, at least ¼ inch in diameter, over the swollen area should be removed; and the exudate should be forced out by pressure with the thumb and forefinger. Next, a piece of cotton saturated with the drug to be used can be inserted into the sinus to permit drainage and to prevent excessive dust collection. Care should be taken to avoid undue injury to the lining of the sinus. The treatment should be repeated every few days until improvement is noted.

It is a good plan, at the beginning of an outbreak, to send a representative specimen to a diagnostic laboratory in order to check on the possible presence of other diseases. Treatment is usually less successful than many salesmen lead one to believe, and too much faith should not be placed in remedies guaranteed to cure sinusitis. There is no experimental evidence to substantiate the claims of manufacturers that so-called "roup bacterins" will prevent or cure this disease. Until a specific cause is found and experimental evidence is available, bacterins cannot be recommended.

Although it is not definitely known that turkeys which recover from

sinusitis remain carriers the following year, all contact between them and growing poults should be avoided. If a recovered flock must be used for breeding, the eggs should be hatched in an incubator, and the poults brooded artificially. As soon as enough eggs are obtained for producing the desired number of poults, the breeding flock should be put into condition and sold for meat purposes to avoid possible contact with the poults during the rearing season.

TUMORS

Tumors of the ovary and less often of other organs have been a common cause of mortality in breeding turkeys on a few ranches. They have been more numerous in two- and three-year-old turkey hens than among the hens kept for only one year. The cause is unknown. The problem is not serious as yet, but turkey growers are cautioned against using breeding stock that has a tendency towards a high tumor incidence.

WORM INFESTATIONS[59]

CAPILLARIA WORMS

Eleven different species of the genus *Capillaria* have been reported from domestic fowls. Of these only three have been reported from turkeys: they are *Capillaria annulata* from the crop and esophagus and *C. meleagris-gallopavo* and *C. columbae* from the intestines. Their eggs are oval with transparent pluglike structures at each end. The infection is apparently direct, no intermediate host being required. Though all three species have been found in California turkeys, none has as yet proved to be of much economic importance. Prevention is the same as outlined for other parasites. The treatments recommended for the cecum worm are said to be effective for the intestinal forms. No satisfactory treatment has been found for the crop form.

CECUM WORMS

Cecum worms (*Heterakis gallinae*) are of economic importance because of their relation to the blackhead (p. 70–76). Widely distributed in chicken-growing areas, they serve as carriers of the blackhead parasite in both turkeys and chickens. These tiny parasites, ½ to ¾ inch in length, are found in the ceca. Prevention and control are described under "Blackhead." Treatment is difficult because of the sheltered position of the worms within the ceca. Large doses (2 to 4 per cent) of finely pulverized tobacco dust in the mash have been known to remove them. The

[59] This section and the following one on "External Parasites" have been prepared in coöperation with Stanley B. Freeborn and Lester Berry.

use of tobacco dust in the ration over a long period as a preventive measure is usually of doubtful value. If turkeys are reared according to the methods recommended, little trouble with cecum worms will be experienced.

GAPE WORMS

The gape worm (*Syngamus trachea*) does little damage in turkeys; but in chickens it clogs the windpipe, and causes the birds to gasp for air—hence the name. The worm is a reddish color. The female may be ¾ inch long; the male seldom more than ¼ inch. Usually the female clings to the lining of the windpipe with the male attached to her in copulation in the form of the letter "Y." The eggs pass up the windpipe with the mucus, are swallowed, and pass from the body with the droppings. After a week to a month in the open air (according to the temperature), a fully developed embryo capable of infesting a healthy bird is formed. It may be ingested by the bird in the egg stage or as a free-living worm. There is evidence that eggs and free-living embryos may survive for some time in the alimentary canal of the earthworm, and thus be protected when they might otherwise perish from drying or from other unfavorable ecological conditions. The young gape worm, taken by the bird as a developed egg, a free-living larva, or in the body of an earthworm, penetrates the walls of the alimentary canal, is carried to the lungs, and works its way up the windpipe, where it attaches itself and sucks blood.

Mature turkeys may carry the infestation through life without showing symptoms. Such birds are a dangerous source of infestation to both young turkeys and young chickens.

Treatment consists in removing the worms mechanically with patent implements, with clipped feathers dipped in kerosene, or with looped horsehairs. Prevention consists in rearing turkeys on sandy, well-drained soil where earthworms are scarce and where the chances are good that the larval gape worms will perish by drying.

To date no infestations by this parasite have been seen by any of the diagnostic centers in California. *Turkey growers are urged to report any suspected cases.*

ROUNDWORMS

The roundworm (*Ascaridia galli*), a common intestinal parasite of chickens, has no economic importance for the turkey industry in California. Less than 1 per cent of all turkeys examined by the diagnostic laboratories of the University and the State Department of Agriculture over a five-year period ending January 1, 1935, were found to be infested with these parasites. In the few cases diagnosed, the roundworms were

not the primary cause of the diseased condition in the flock, since only a few of them were found on autopsy.

According to Ackert and Eisenbrandt,[60] turkeys are more resistant than chickens to infestation with the common roundworm. Turkey growers are therefore warned against treating their flocks for this parasite; at present, at least, the spending of money for roundworm remedies is wasteful. The sanitary procedures for preventing blackhead, fowl typhoid, coccidiosis, and other diseases will automatically ward off roundworm infestation.

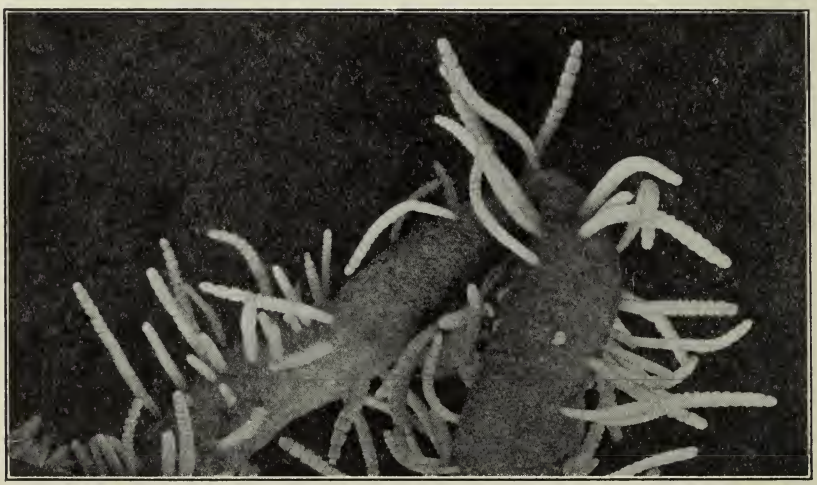

Fig. 53.—Tapeworms attached to inner wall of the intestine (×2). The worms appear somewhat longer and more transparent at the time of post-mortem examination. (From Cir. 251.)

TAPEWORMS

Tapeworms, in contrast to roundworms, are common in turkey flocks of certain sections of California. The effect of an infestation in turkeys is so insidious that the cause is often either not suspected or entirely overlooked. The tapeworm, an inhabitant of the intestines, ranges when full-grown from almost microscopic size to 10 inches, according to the species. It has a "head" or scolex by which it attaches itself to the walls of the intestines (fig. 53). When freshly deposited, the individual segments appear as glistening white, pearly objects, which move about slowly by expanding and contracting. If the eggs are eaten by some other animal, the young tapeworm develops up to a certain stage in the

[60] Ackert, J. E., and L. L. Eisenbrandt. On the comparative resistance of Bronze turkeys and White Leghorn chickens to the nematode *Ascaridia lineata* (Schneider). Jour. Parasitol. 20(2):129. 1933.

body of this intermediary host, where it remains dormant until the host is eaten by turkeys. Then the larval tapeworm again becomes active and matures, sloughing off more segments full of eggs.

Most of the tapeworms that infest chickens also infest turkeys. Figure 54 shows the scolices, or "heads," of six species. Flies, slugs, dung beetles,

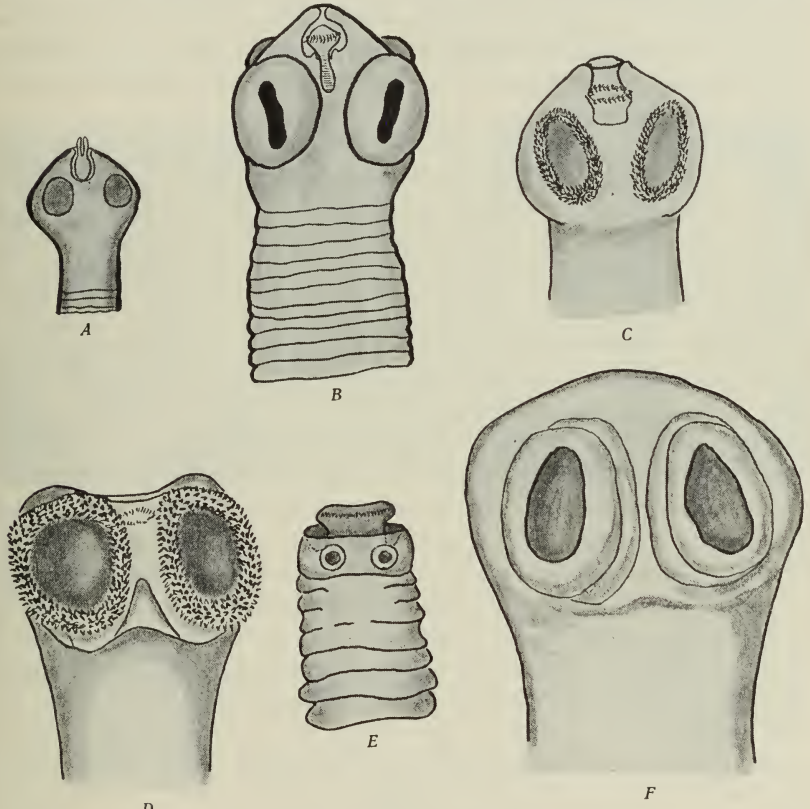

Fig. 54.—Scolices or "heads" of the common poultry tapeworms greatly enlarged but drawn to the same scale: *A, Hymenolepis carioca; B, Choanotaenia infundibulum; C, Raillietina tetragona; D, Raillietina echinobothrida; E, Raillietina cesticillus; F, Metroliasthes lucida.* (From Ext. Cir. 8.)

earthworms, and snails are common intermediary hosts—an important fact when one is considering methods of preventing and controlling tapeworms.

The common poultry tapeworm (*Choanotaenia infundibulum*) is the species most generally encountered in California turkeys. The intermediate hosts of this species are the housefly (*Musca domestica*) and the dung beetle.

Prevention, Control, and Treatment.—The whole prevention program

should be built around a scheme for eliminating, as far as possible, the intermediate hosts of tapeworms. Frequent removal of manure and litter from brooder houses and prevention of heavy fly populations in turkey-feeding areas will be helpful. Such refuse should be placed in fly-proof storage bins, or scattered where flies will not breed. Barnyards or corrals, which are common feeding grounds for dung beetles and flies, should be avoided. As liquid milk and other liquid or semiliquid feeds attract millions of flies, they should not be used if the region is heavily infested with tapeworms.

Control of tapeworm infestation in a flock depends on eliminating the intermediate host and removing the parasites from the primary host, the turkey. Changing the feeding area and at the same time shifting gradually from liquid or semisolid feeds, to dry mashes is advisable. Tapeworm remedies, if used, should be administered several days before the birds are to be moved to a new range.

No highly efficient treatment has been developed for removing tapeworms from turkeys. Kamala, recommended for their removal from chickens, is sometimes toxic for turkeys; it should be tried out on a few poults at least 48 hours before the entire flock is to be treated. The dose of kamala for turkeys is from ¼ to 1 gram per bird, according to age and size. Recommendations of the manufacturer or of the veterinarian from whom the kamala is purchased should be carefully followed. *Combination pills or capsules for the removal of both roundworms and tapeworms are not recommended.* Periodic flock treatments, such as suggested by many manufacturers and by many turkey growers, are of little or no value. Under no consideration should any treatment be given unless tapeworms are known to be causing losses in the flock.

EXTERNAL PARASITES

LICE

Lice can be distinguished from all other parasites on the body because they have three pairs of legs and because their bodies, divided into three sections—head, thorax, and abdomen—are flattened dorso-ventrally, as if a flattening force had been applied on their backs (fig. 55). They are seldom over 3/16 inch in length and are yellow or grayish, sometimes ornamented with dark stripes, but never uniformly dark brown or red. Parasites of the latter colors may be fleas, mites, or ticks.

The entire life of the louse, including the egg stage, is spent on the body of the bird. Only by accident do the insects leave their hosts, except to migrate to other hosts of the same species. The eggs require about a week to hatch, after which maturity is reached in about two weeks.

At least four species of lice from turkeys have been reported in the United States. The common body louse of chickens, *Menopon stramineum* is usually found on turkeys associating with chickens. The shaft louse of chickens, *Menopon gallinae,* has also been found on turkeys; but its presence is probably accidental. The large turkey louse, *Goniodes meleagridis,* and the slender turkey louse, *Lipeurus gallipavonis,* are, in all likelihood, native to the turkey. The large louse is the more common. Rearing turkeys in close confinement and in insanitary quarters favors

Fig. 55.—Three common species of poultry lice. (From Cir. 251.)

lice more than does range rearing. Breeding flocks and especially setting hens are liable to be heavily infested if not treated periodically.

Prevention and Control.—Prevention of lice consists in following the practices already outlined for the prevention of other diseases. In known infested areas, periodic dusting of the turkeys with sodium fluoride will protect against marked lice infestation. Turkey hens should be dusted before being placed on eggs and again just before the eggs are hatched.

None of the present-day remedies is harmful to the egg of the louse. It is necessary to use a substance that will remain on the body long enough to kill the emerging young or else to give a second treatment between 8 and 14 days after the first.

Sodium fluoride is apparently the only remedy that answers the requirement of eliminating lice in any stage except the egg with a single treatment. It also has the advantage (1) of being safe to both birds and operator, (2) of eliminating the lice completely, and (3) of being suitable for poults and setting hens. Sodium fluoride may be obtained from drugstores as a white powder (commercial form) or as crystals (chemically pure).

It may be applied in any of three ways: the "pinch" method, dusting,

or dipping. The pinch method consists of placing on the skin of each fowl approximately ten "pinches," the amount held between thumb and forefinger, of the commercial sodium fluoride at the following places: on the breast, on each thigh, below the vent, on each side of the back, on the neck, on the head, and finally on the underside of each outspread wing. This is the most effective method of treating turkeys. The birds, when treated, should be held over a shallow pan or newspaper so that any excess of the chemical may be saved. The powdered sodium fluoride is sometimes mixed with three or four times its bulk of flour or talc and dusted on with a large shaker, the feathers of the bird being ruffled as the chemical is applied. This procedure is less economical and less efficient than the pinch method, and the excess of the chemical in the air is irritating to birds and operators.

The amount of sodium fluoride varies with the efficiency of the person applying the powder and the method used for saving the excess. According to data obtained from growers, approximately 10 pounds of sodium fluoride per 1,000 adult turkeys is required when the pinch method is used.

A dust bath for preventing lice infestation can be made by mixing sodium fluosilicate and fine road dust at the rate of 1 part of the chemical to 3 parts of the dust. New birds should be treated for lice at the beginning of the quarantine period and again a day before being placed with the flock.

Nicotine sulfate (Black Leaf 40) applied to the roosts is an efficient and specific poison for lice; but, under the common California method of rearing turkeys out of doors, it cannot be used efficiently.

MITES

Turkeys are less troubled with mites than chickens, probably because of the difference in methods of rearing. Occasionally, however, reports of turkeys infested with one of the numerous varieties of mites that attack chickens are received. In practically all such instances, association with chickens or rearing in houses formerly used by chickens is responsible. For detailed information on mites, the reader is referred to a treatise on poultry diseases.

If an old chicken house is to be used for sheltering turkeys, the roosts and cracks in the walls should be carefully examined for the common poultry mite, *Dermanyssus gallinae*. A thorough cleaning of the house and the liberal use of oil sprays will aid in ridding the house of mites. Wood preservatives such as Carbolineum are excellent; they may be diluted with an equal amount of kerosene. With this type of spray, one

careful, thorough treatment usually proves sufficient. All old nests and rubbish should be removed from an infested house and burned before spraying is started.

The scaly-leg mite, *Cnemidocoptes mutans,* occasionally causes the characteristic scaly leg in turkeys. This mite burrows beneath the scales of the leg; its presence and activities cause a lifting of the scales and a swollen condition of the shank which, in advanced cases, result in such distortion and deformity that the affected birds cannot walk. It is seldom seen except in old birds.

Treatment consists in dipping the legs of the birds in a mixture of equal parts of crude oil and raw linseed oil, taking precautions to avoid wetting the legs above the scaly portion. After three weeks, unless marked improvement is noted, the treatment should be repeated. This, however, is seldom necessary. The legs of newly acquired birds should be observed carefully in order that infected birds may be segregated and treated before being placed with the clean flock.

TICKS

Although ticks molest turkeys, heavy infestations are rare unless turkeys are reared in old tick-infested chicken yards or houses. The ticks, though closely related to the mites, are always larger, being easily visible to the naked eye, and have a thick, leathery cuticula or skin.

The only tick of economic importance that attacks fowls is the so-called "fowl tick" or "blue bug," *Argas persicus.* The adult tick is flat, egg-shaped in outline, dark brown in color, from ¼ to 7/16 inch in length and about half as wide at its widest part. Its habits are essentially like those of the common chicken mite. It has a remarkable ability to live for long periods without food, the specimen photographed in figure 56 having fasted thus in a tightly corked vial for a period of sixteen months. Records are available of adult ticks that have fasted for two and a half years.

Prevention, Control, and Treatment.—Turkeys that have been purchased for replacements, or birds that have been temporarily removed from the flock for loan or show purposes, should be carefully inspected for ticks (fig. 56). Thighs, breast, and sides should be examined for the roundish, bluish-red, larval ticks, which are easily seen because of the contrast in color between their bodies and the birds' skin. Chickens and other fowl brought on the premises should also be inspected. The usual quarantine procedure recommended for the prevention of other diseases should be observed.

Treatment is the same as for the common chicken mite except that the

spray material should be stronger in every case when the dilution is made with water. The wood preservers made of anthracene oil stand out as the most promising remedies, but treatment with these must often be repeated at the end of three or four weeks. If sheep-dip or other stock dips are used, their dilutions should be at least as strong as 1 part of dip

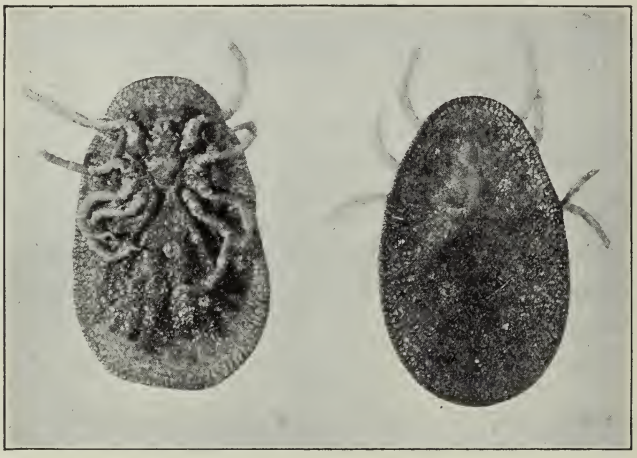

Fig. 56.—Ventral and dorsal view of the poultry tick, or blue bug, enlarged. (From Cir. 251.)

to 4 parts of water. Sometimes individual fowls show signs of weakness when heavily infested with larvae which are taking a first meal and which remain attached for several days. Such birds should be immersed in a 2 per cent coal-tar dip. The usual practice, however, is merely to segregate the infested birds for a few days in an isolated coop until the ticks become engorged and drop off. Then the birds may be returned to the flock, and the coop destroyed or disinfected with boiling water or with one of the sprays mentioned above.

17*m*-12,'37(470)